This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Main Lib.
Forestry

January 1923.

FORESTRY PAMPHLETS

MASSACHUSETTS

Vol. X.

Laws Relating To Forestry and the Suppression of the Bypsy and Brown-tail moths. By F. W. Rane, State Forester. July 1, 1918.

Forest Mensuration. By H. O. Cook, Chief Forester. The Commonwealth of Massachusetts. 1921.

Seventeenth Annual Report of the Massachusetts Forestry Association. Bulletin #115. 1914.

Massachusetts and Her Forests. By Frank W. Rane State House, Boston, Sept. 15, 1919.

Why Massachusetts Needs Town Forests. Massachusetts Forestry Association. Bulletin #132. October 1921.

The Massachusetts State Forester. Sixteenth Annual Report, 1919. By Frank W. Rane.

Reforestation in Massachusetts. By T. R. Simmons. 1919.

Annual Report of the Commissioner of Conservation and State Forester for the year ending November 30, 1920. Public Document #73. The Commonwealth of Massachusetts.

Annual Report of the Commissioner of Conservation and State Forester for the year ending November 30, 1921. Public Document #73.

Growth Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England. By J. Nelson Spaeth. Harvard Forest Bulletin #2. 1920

The Life History and Control of the Pales Weevil. By H.B. Peirson. Harvard Forest Bulletin#3 1921

Red Oak and White Ash. By Reuben T. Patton, HarvardForest Bulletin #4, 1922.

Notes and Correspondence on Massachusetts Publications:

Letter sent out by the Massachusetts Horticultural Society for information on roadside trees. 1899.

Act to provide for the Purchase of forest land and for reforestation. Approved May 1, 1908.

Blank application for an Examination of Forest Lands to the Massachusetts State Forester.

Letter from Massachusetts Forestry Assoc., regarding exhuasted supply of the 1919 Report on National Parks and Forests. August 10, 1921.

Letter from the State Forester, Commonwealth of Massachusetts, regarding land for forest demonstration purposes.

Circular letter from State Forester, Commonwealth of Massachusetts, regarding publications for sale.

Forestry

SD144
M2T3
v.10
CALIFORNIA

The Commonwealth of Massachusetts

LAWS

RELATING TO

FORESTRY

AND THE SUPPRESSION OF THE

GYPSY AND BROWN-TAIL MOTHS

By

F. W. RANE, STATE FORESTER

Room 408, State House, Boston, Mass., U. S. A.

1914
ditions have been favorable, which, in turn,
has been utilized as soon as it reached mer-
chantable size. Demand for forest products
1

CALIFORNIA

Publication of this Document
approved by the
Supervisor of Administration.

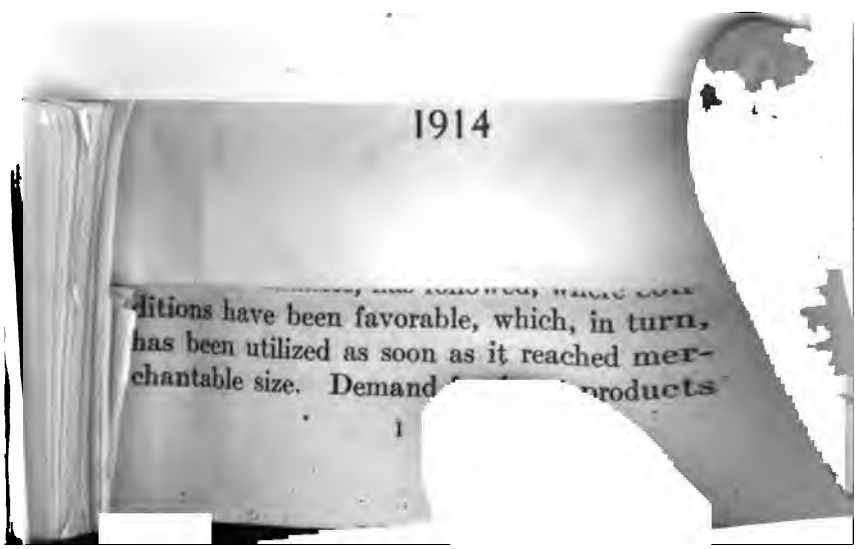
INTRODUCTION.

The last general edition of the forest laws of this Commonwealth was issued in 1909. Our supply of the little blue booklet in which these laws were contained has long since been exhausted. Since that time both the fire laws and gypsy moth laws have been amended, and special editions of these laws have been published, but our supply of these, too, has been used up. We do not include in this booklet the forest taxation law, because this act is bound in a separate pamphlet, and its inclusion in this booklet is unnecessary. This publication does not contain the shade-tree laws of the Commonwealth, although it might fittingly do so, because the enforcement of these laws does not come within the jurisdiction of the State Forester. We are always glad, however, to advise with any one in regard to these laws and other shade-tree problems.

The chapter on the work of the Massachusetts forestry department may help to make clear the meaning of the laws on which our work is based.

F. W. RANE,
State Forester.

JULY 1, 1918.


1914
ditions have been favorable, which, in turn,
has been utilized as soon as it reached mer-
chantable size. Demand
products

CONTENTS.

	PAGE
Introduction	3
Gypsy Moth Suppression	7
Forest Utilization	8
Forest Fire Prevention	9
General Forestry	10
State Forest Commission	12
Massachusetts Forest Laws	13
The State Forester	13
Reforestation	16
State Forest Commission	19
Town Forest Law	21
Forest Fire Laws	25
Forest Wardens in Cities and Towns	25
Powers of Forest Wardens	27
Setting of Fires in the Open Air	29
Disposal of Slash	31
Exemplary Damages, etc.	32
Lands adjoining Railroads	33
Town Appropriations	36
Use of Spark Arresters	37
Close Season for Game	38
Punishable Offences	39
Laws relating to Gypsy Moth Suppression	42
Act to provide for Suppression of Gypsy and Brown-tail Moths	42
Act relative to Abatement of Taxes	53
Act to authorise Local Superintendents to furnish Lead	54
Act to authorise Cities and Towns to suppress Tent Caterpillar, etc.	55
Act to authorise Cities and Towns to purchase Arsenate of Lead	56

1914

...tions have been favorable, which, in turn, ...has been utilized as soon as it reached mer-...chantable size. Demand for forest products

THE MASSACHUSETTS FORESTRY DEPARTMENT.

The work of the State Forester is divided into four branches, under separate administrative heads, as follows: gypsy moth, forest fires, forestry, and forest utilization. We do not mean to indicate that there is a distinct line of cleavage between these four branches and that each works independently of the other. The object of the State Forester, as stated by law, is the perpetuation, extension, protection, and proper management of the forest lands of the Commonwealth, both public and private (Acts of 1904, chapter 409, section 2). All of these branches work together to produce this result, and their work must interlock, as their interests are united.

Gypsy Moth Suppression.

The law provides that each individual town shall care for the suppression of the gypsy and brown-tail moths within its borders through a local superintendent appointed by the selectmen or mayors and approved by the State Forester. In carrying out measures for such suppression, the local superintendent acts under the direction of the State Forester, his deputized assistant, and district superintendents. We shall not go into detail in regard to the financing of this work as provided by law as the details are somewhat complicated. Suffice it to say that each town has a liability which is one twenty-fifth of one per cent. of its valuation. This sum, which amounts to only a few hundreds in small towns

...tions have been favorable, which, in turn, ...as been utilized as soon as it reached mer-...chantable size. Demand for forest products

and runs up to five thousand dollars in cities, the community must spend from its own funds, provided the conditions call for it. Where amounts in excess of the liability are spent by the towns, the whole or portion of said excess is reimbursed by the State to the town, such reimbursement depending upon the valuation of the town. Formerly such reimbursement was paid in money, but now such payments are made as far as possible in the form of supplies, as it has been found that the State can secure supplies cheaper than the towns and thus the money goes further.

In combating insects the State forester is limited to work against the gypsy and brown-tail moths. In regard to other insects he can act only in an advisory capacity, and if towns wish to combat such a pest they must do so at their own expense, through a special appropriation.

The State Forester is superintendent of moth work. He has an assistant who supervises the work of the five district moth superintendents. There is in addition a purchasing agent, who looks after the buying and distribution of the supplies used in the moth work and incidentally does the same service for the other branches of the Department.

Forest Utilization.

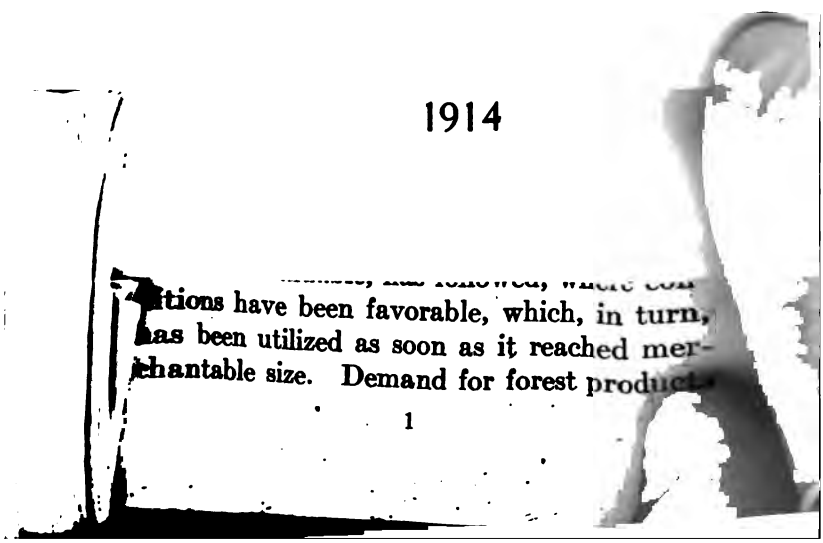
Special conditions sometimes call for an effort not specifically provided for by law, and such is the work of this branch. Owing to the depredations of the gypsy moth, a great deal of the oak timber in the eastern part of the State has been killed or partially killed, and the normal market for this material was overflowed, with the result that much valuable wood was going to waste because there was no profitable outlet for it. Furthermore, it has been scientifically dem-

onstrated that mixed woodland which has not yet been seriously infested can be in part protected by the removal of the trees most susceptible to the gypsy moth. The conditions that have come to pass in the oak woodlands of the eastern part of the State are also present in the chestnut stands of the central and western sections, because of the effects of the bark disease. For the purpose of finding a market for the unmarketable material, and to assist the owner in getting this material ready for the market, this branch of the work was organized. The utilization branch not only finds the market for the private owner but supervises the operation of the woodlot, placing the contracts for cutting, milling, etc., and selling the product. The owner, of course, pays all the costs except the supervision. Although this branch is at present chiefly interested in oak and chestnut and their products, the market information which it gathers extends to all species of wood and classes of products. The advantage to the Commonwealth of this work is that material which would likely go to waste is placed upon the market, and that woodlot owners, receiving a better price for their product than they were accustomed to receive, are encouraged to think better of forestry as a woodland investment than they otherwise would.

The forester in charge of this branch has two assistants, one in the field and one in the office, besides several field foremen who take charge of the cutting and logging operations on the estates under his care.

Forest Fire Prevention.

The work of fighting forest fires in each town is in the hands of a local forest warden, who is appointed by the mayor or selectmen with the approval of the State Forester. The


1914
tions have been favorable, which, in turn,
as been utilized as soon as it reached mer-
chantable size. Demand for forest
1

local wardens act under the general supervision of the State Fire Warden and his district deputies. The entire expense of fire fighting is borne by the towns, except in the case of railroad fires where they can collect from the corporation. The State Fire Warden can, however, compensate certain small towns for fifty per cent. of the value of fire-fighting equipment which they purchase with his approval. Aside from the supervision of local wardens the efforts of the State fire service are directed towards the prevention and quick detection of fires. The first line of work is carried out by the publishing of the fire laws on posters and by other means, the inspection of spark arresters on locomotives and the clearing of rights of way. The second is secured by a complete system of fire watch towers, now numbering thirty-six, which are connected by telephone with the local wardens in their district. Watchmen are maintained in these towers for about six or seven months in the year.

This Department maintains two fire trucks in the central and western parts of the State for use at fires which have got beyond the control of the local authorities.

The State Forester, as head of the fire service, deputizes his powers to a State Fire Warden, who has the assistance of fire district wardens and the watchmen mentioned above.

General Forestry.

We have left this branch until the last for under it are gathered a variety of activities which the other branches with their more definite work do not touch. It is a sort of general utility branch. The work of this branch may be subdivided into five lines, although these lines do not necessarily cover

all its work, for special temporary activities are placed upon it from time to time.

(*a*) *Reforestation.* — Under the reforestation law (Acts of 1907, chapter 487) owners of cut-over and waste land who wish to have it reforested can turn over their land to the State Forester for a period of ten years. At the expiration of this period the owner can reclaim his land by paying what the Department has laid out upon it for planting and other work. To date one hundred and fifty plantations, amounting to six thousand acres, have been reforested under the terms of this law.

(*b*) *State Nurseries.* — This branch maintains two principal and three sub or transplant nurseries for the propagation of forest planting stock. This stock is grown, first, for use of the Department for planting on reforestation lots and State forests; second, for use by other State departments; third, for municipalities; and last, for sale at cost to private owners.

(*c*) *Examination.* — The forest law provides that any owner of woodland may call on the State Forester for an examination of his woodland or trees. The cost of such an examination to the owners covers the traveling expenses of the visiting forester. The subjects covered in such examinations range from an estimate of timber to the identification of a disease on a tree or shrub.

(*d*) *State Forests.* — Under the law the State forests purchased by the State Forest Commission are turned over to the State Forester for administration. As the Legislature has made no special appropriation for this purpose, the amount of work done along this line is limited, but considerable has been done in the construction of fire lines, wood roads, and planting.

1914
ditions have been favorable, which, in turn,
has been utilized as soon as it reached mer-
chantable size. Demand for forest products
1

(e) *Educational Work.* — This is carried on by the publication of bulletins, the dissemination of newspaper articles, the arrangement of exhibits at fairs, and other public celebrations, through correspondence, and by personal interviews.

There is an assistant forester in charge of the work in this Department and two other foresters, one of whom is located at Springfield. There are three nursery foremen and three field foremen, who are permanent employees.

State Forest Commission.

Although this department is not a part of the State Forester's office, it is so closely associated with it that a review of this kind would not be complete unless it were mentioned. Upon this commission is placed the duty of selecting and purchasing large areas of waste land at prices not to exceed five dollars per acre for reforestation and management on the part of the State Forester. He is, in fact, one of the three commissioners. They have only one permanent employee, an engineer, who carries out the directions of the commission in getting together the land and making the necessary surveys. There are at present four State forest reservations, containing in all about eleven thousand acres.

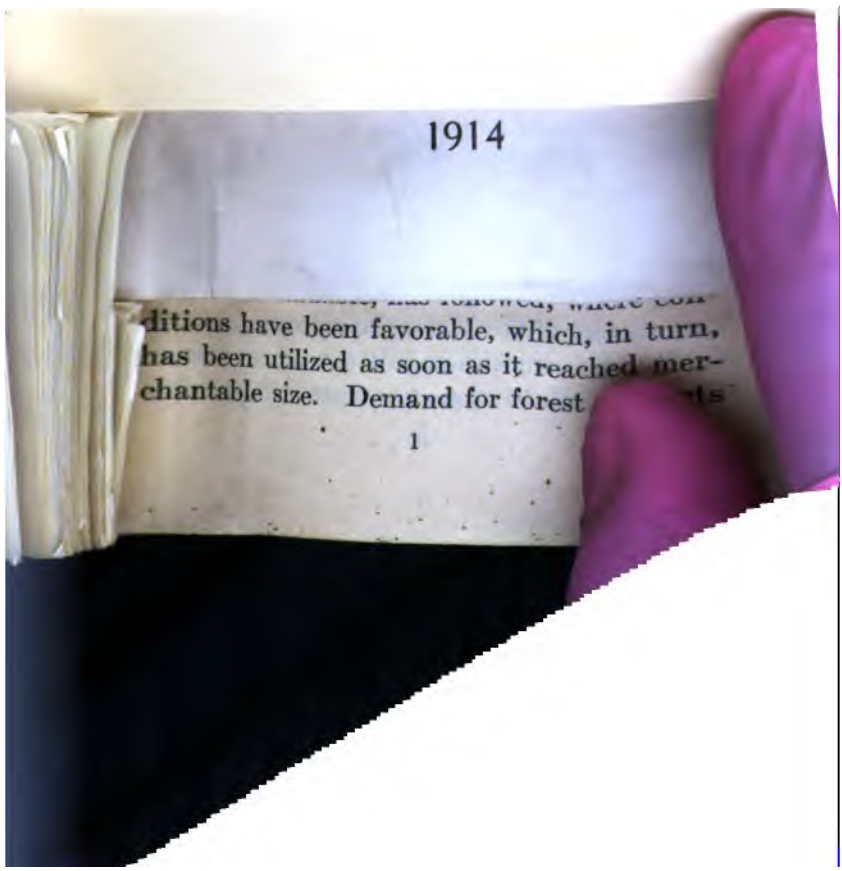
MASSACHUSETTS FOREST LAWS.

GENERAL FORESTRY.

The State Forester.

1904, 409, sect. 1, as amended, 1907, 473, 1909, 263, and G. A. 1917, 63. The governor, with the consent of the council, shall appoint an officer to be known as the state forester, and shall determine his salary. He shall be a trained forester who has had a technical education. He shall act for the commonwealth in suppressing the gypsy and brown-tail moths as public nuisances. The governor may, with the consent of the council, remove the state forester at any time for such cause as he shall deem sufficient. In case of the death, removal or resignation of the state forester the governor shall forthwith appoint a successor. The state forester shall be furnished with an office in the state house and may expend for the services of clerks, stenographers and other office assistants, for travelling expenses necessarily incurred in the discharge of his duties, for office supplies, and for incidental expenses, including the printing and binding of his annual report, such sums as the general court shall annually appropriate. The office of superintendent for suppressing the gypsy and brown-tail moths is hereby abolished. All the powers, rights, duties and liabilities of the said superintendent are hereby transferred to the state forester. No existing contracts, proceed-

Appointment and qualifications.


1914
ditions have been favorable, which, in turn,
has been utilized as soon as it reached mer-
chantable size. Demand for forest
1

ings or liabilities shall be affected hereby, but the state forester shall in all respects and for all purposes be the lawful successor of the superintendent for suppressing the gypsy and brown-tail moths.

1904, 409, sect. 2. It shall be the duty of the state forester to promote the perpetuation, extension and proper management of the forest lands of the commonwealth, both public and private. He may upon suitable request give to any person owning or controlling forest lands aid or advice in the management thereof. He shall give such a course of instruction to the students of the Massachusetts Agricultural College on the art and science of forestry as may be arranged for by the trustees of the college and the forester; and shall perform such other duties from time to time as may be imposed upon him by the governor and council. The state forester shall have the right to publish the particulars and results of any examination or investigation made by him or his assistants as to any lands within the commonwealth, and the advice given to any person who has applied for his aid or advice. Any recipient of such aid or advice shall be liable to the state forester for the necessary expenses of travel and subsistence incurred by him or his assistants. The state forester shall account for moneys received under this clause according to the provision of section five.

Duties of state forester.

1904, 409, sect. 3. The state forester may establish and maintain nurseries for the propagation of forest tree seedlings upon such lands of the commonwealth, at the Massachusetts Agricultural College at Amherst, or at any other state institution, as the superintendent or trustees of the institution may set apart for this purpose. Superintendents of institutions where land is set apart for this purpose may furnish free of cost the labor of their inmates

Establishment of nurseries.

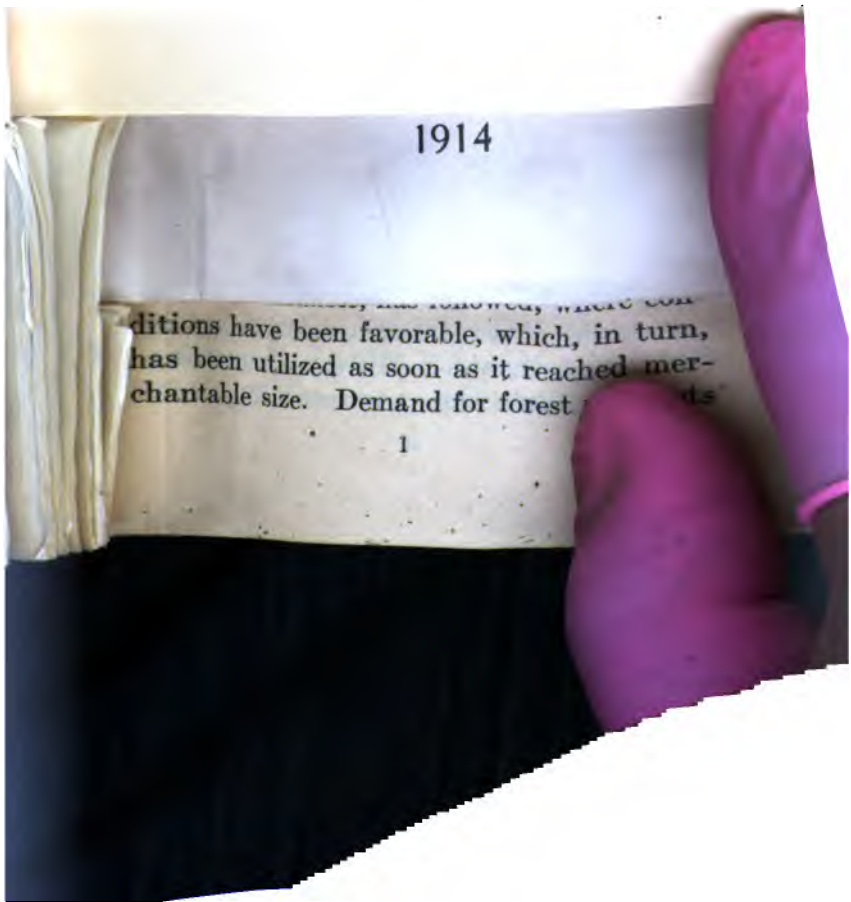
necessary to establish and maintain the said nurseries. Seedlings from these nurseries shall be furnished to the commonwealth without expense for use upon reservations set aside for the propagation of forest growths for other than park purposes. All stock grown in nurseries established under the provisions of this act shall be used within the limits of the commonwealth and shall be furnished to state institutions free of charge. The state forester may distribute seeds and seedlings to land owners, citizens of the commonwealth, under such conditions and restrictions as he may determine, subject to the approval of the governor and council.

1904, 409, sect. 4. The state forester is hereby empowered, subject to the approval of the governor and council, to hire such assistants as he may need in the performance of his duties, and to fix their salaries. **Forestry assistants.**

1904, 409, sect. 5. The state forester shall annually, on or before the thirty-first day of December, make a written report to the general court of his proceedings for the year ending on the thirty-first day of December, together with such recommendations as he may deem proper, and with a detailed statement of the receipts and expenditures incident to the administration of his office. **Forester's report.**

1904, 409, sect. 6, as amended, 1907, 473, sect 2. Such sums as the general court shall authorize may be expended annually by the state forester, with the approval of the governor and council, in carrying out the provisions of this act. **Expenditures.**

1911, 722, sect. 1. The state forester is hereby empowered to appoint an assistant to be known as the state fire warden, whose special duty it shall be to aid and advise the forest wardens and their deputies in towns and the municipal officers exercising the functions **Appointment of state fire warden.**


1914
ditions have been favorable, which, in turn,
has been utilized as soon as it reached mer-
chantable size. Demand for forest
1

of forest wardens in cities, in preventing and extinguishing forest fires and in enforcing the laws relative to forest fires, and may from time to time designate not more than fifteen deputies to aid such state fire warden in the discharge of his duties.

1911, 722, sect. 2. The state fire warden appointed under the terms of section one shall report annually upon his work and upon the forest fires occurring in the commonwealth, and his report shall be included in and be printed as a part of the state forester's annual report.

Annual report.

1911, 722, sect. 3. The deputies of the fish and game commissioners shall report to the state fire warden the situation and extent of any forest fire occurring within the district to which they are assigned, and they shall report to him monthly their doings under chapter two hundred and ninety-nine of the acts of the year nineteen hundred and seven.

Reports from deputies of fish and game commissioners.

Reforestation.

1908, 478, sect. 1, as amended, 1909, 214. For the purpose of experiment and illustration in forest management and for the purposes specified in section seven of this act, the sum of five thousand dollars may be expended in the year nineteen hundred and eight, and the sum of ten thousand dollars annually thereafter, by the state forester, with the advice and consent of the governor and council, in purchasing lands situated within the commonwealth and adapted to forest production. The price of such land shall not exceed in any instance five dollars per acre, nor shall more than eighty acres be acquired in any one tract in any one year,

Purchase of land.

except that a greater area may so be acquired if the land purchased directly affects a source or tributary of water supply in any city or town of the commonwealth. All lands acquired under the provisions of this act shall be conveyed to the commonwealth, and no lands shall be paid for nor shall any moneys be expended in improvements thereon until all instruments of conveyance and the title to be transferred thereby have been approved by the attorney-general and until such instruments have been executed and recorded.

1908, 478, sect. 2. The owners of land purchased under this act, or their heirs and assigns, may repurchase the land from the commonwealth at any time within ten years after the purchase by the commonwealth, upon paying the price originally paid by the commonwealth, together with the amount expended in improvements and maintenance, with interest at the rate of four per cent per annum on the purchase price. The state forester, with the approval of the governor and council, may execute in behalf of the commonwealth such deeds of reconveyance as may be necessary under this section: *provided, however*, that there shall be included in such deeds a restriction requiring that trees cut from such property shall not be less than eight inches in diameter at the butt. **Repurchase by owners.**

1908, 478, sect. 3. The state forester may in his discretion, but subject to the approval of the deed and title by the attorney-general as provided in section one, accept on behalf of the commonwealth gifts of land to be held and managed for the purpose hereinbefore expressed. A donor of such land may reserve the right to buy back the land in accordance with the provisions of section two, but in the **Gifts of land.**

1914
ditions have been favorable, which, in turn,
has been utilized as soon as it reached mer-
chantable size. Demand for forest products
1

absence of a provision to that effect in his deed of gift he shall not have such right.

1908, 478, sect. 4. Land acquired under the provisions of this act shall be under the control and management of the state forester, who may, subject to the approval of the governor and council, cut and sell trees, wood and other produce therefrom.

Control and management.

1908, 478, sect. 5. All moneys received by or payable to the commonwealth or any one acting on its behalf under the provisions of this act shall be paid into the treasury of the commonwealth.

1908, 478, sect. 6. Land acquired under the provisions of this act and subsequently reconveyed under the provisions of sections two or three shall not be exempt from taxation on account of any plantation of trees set out or planted while it was held by the commonwealth.

Taxation.

1908, 478, sect. 7. For the purpose of assisting in reforestation a portion, not exceeding twenty per cent of the money authorized by this act to be expended may be used by the state forester for the distribution at not less than cost of seeds and seedlings to land owners who are citizens of the commonwealth, under such conditions and restrictions as the state forester, subject to the approval of the governor and council, may deem advisable.

Distribution of seeds and seedlings.

1908, 478, sect. 8. The state forester shall replant or otherwise manage all land acquired by the commonwealth and held by it under the provisions of this act, in such manner as will, in his judgment, produce the best forest growth both as to practical forestry results and protection of water supplies.

1908, 478, sect. 9. All acts and parts of acts inconsistent herewith are hereby repealed.

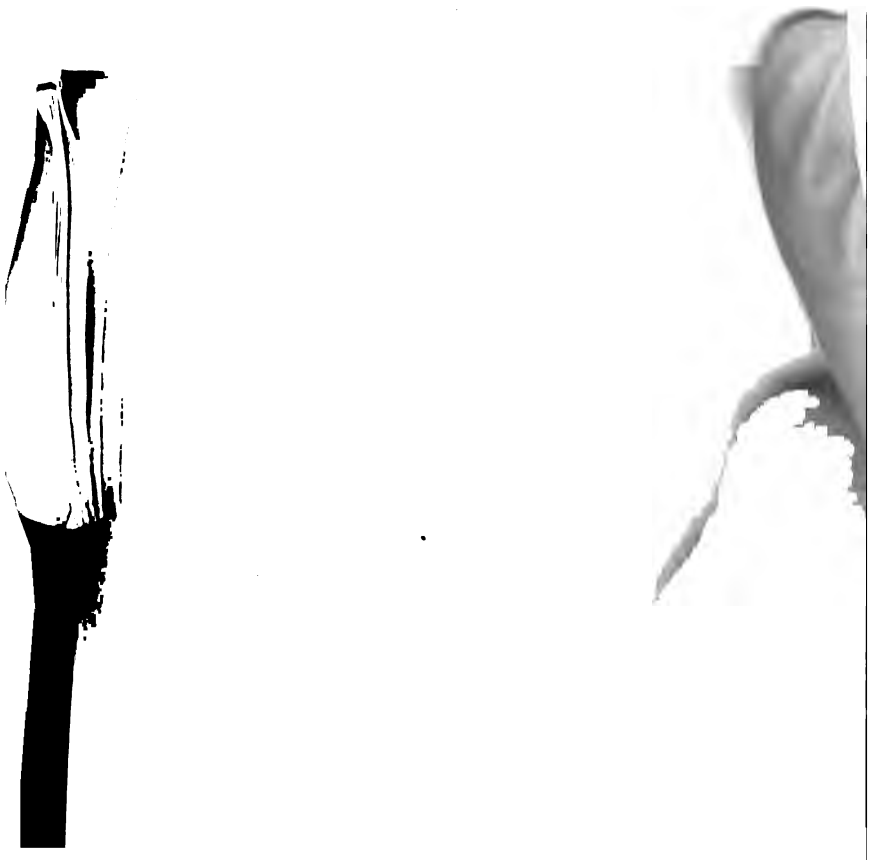
1910, 153, sect. 1. The state forester, with the approval of the governor and council, is hereby authorized to accept, on behalf of the commonwealth, bequests or gifts to be used for the purpose of advancing the forestry interests of the commonwealth, under the direction of the governor and council, in such manner as to carry out the terms of the bequest or gift. **Acceptance of bequests by state forester.**

1908, 121. *Resolved*, That such publications of the state forester as shall be designated by the governor and council may be sold by the state forester at a price not less than the cost thereof; and additional copies may be printed for sale at the discretion of the governor and council, the expense thereof to be paid from the receipts from such sales. Any amounts received from such sales shall be paid into the treasury of the commonwealth. **Forestry publications.**

State Forest Commission.

1914, 720, sect. 1. There is hereby established a state forest commission, to be composed of three persons, one of whom shall be the state forester and two other members who shall be appointed by the governor, with the advice and consent of the council, and who shall serve without compensation. The term of office of the appointive members of the commission shall be six years, except that when first appointed one of the members shall be appointed for six years and one for three years. Thereafter one member shall be appointed every third year. **Appointment.**

1914, 720, sect. 2. The commission shall have power to acquire for the commonwealth by purchase or otherwise, and to hold, woodland or land suitable for timber cultivation within the commonwealth. The com- **Powers.**



mission may, after a public hearing, sell or exchange any land thus acquired which in the judgment of the commission can no longer be used advantageously for the purposes of this act. The average cost of land purchased by the commission shall not exceed five dollars an acre.

1914, 720, sect. 3. Lands acquired under the provisions of this act shall be known as state forests and shall be under the control and management of the state forester. He shall proceed to reforest and develop such lands and shall have power to make all reasonable regulations which in his opinion will tend to increase the public enjoyment and benefit therefrom and to protect and conserve the water supplies of the commonwealth. The state forester shall keep and publish in his annual report an account of all money invested in each state forest and of the annual income and expense thereof.

Control and management of lands.

1914, 720, sect. 4. In the reforestation, maintenance and development of lands purchased under this act, the state forester, so far as is practicable, shall obtain the labor necessary therefor under the provisions of chapter six hundred and thirty-three of the acts of the year nineteen hundred and thirteen, and acts in amendment thereof and in addition thereto.

Labor on forests.

1914, 720, sect. 5. Land acquired under the provisions of this act shall be exempt from taxation; but the commonwealth shall reimburse cities and towns in which such lands are situated for taxes lost by reason of their acquisition, in the same manner and to the same extent as in the case of lands acquired for public institutions under the provisions of chapter six hundred and seven of the acts of the year nineteen hundred and ten.

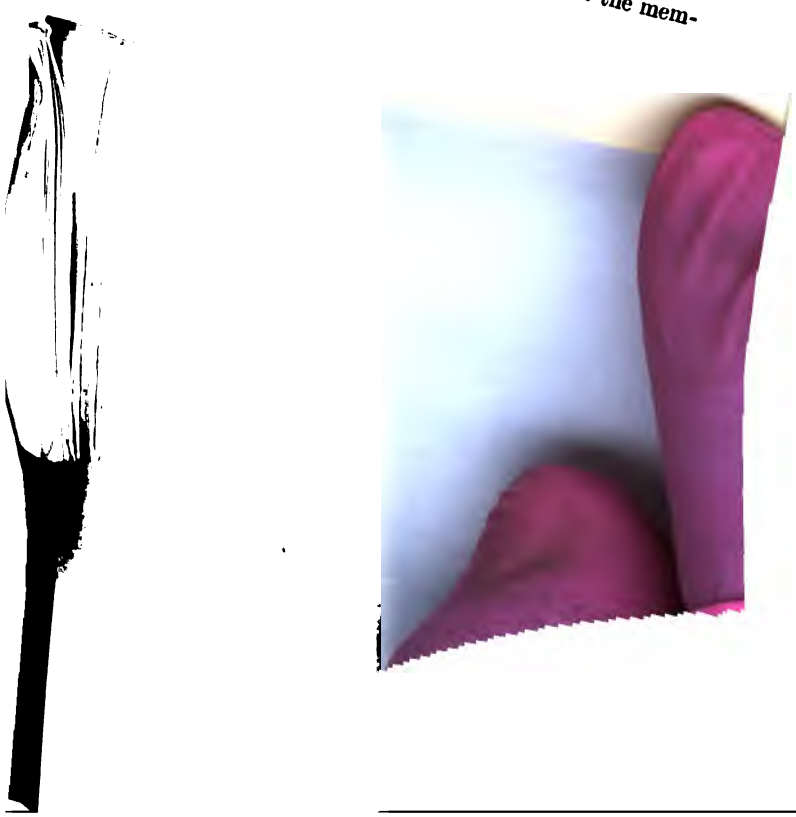
Exempt from taxation.

1914, 720, sect. 6. The sum of ten thousand dollars may be expended during the present year and the sum of twenty thousand dollars may be expended annually for the four succeeding years by the state forest commission in the acquisition of lands under the provisions of this act: *provided*, that the said commission may, at its discretion, authorize the state forester to expend a part of said sum in the maintenance of said lands. If any part of said twenty thousand dollars remains unexpended at the close of any year, the balance may be expended in the following year. The said commission may also expend not more than five hundred dollars annually for its necessary expenses incurred in carrying out the provisions of this act. Appropriations.

Town Forest Law.

Be it enacted, etc., as follows:

1913, 564, sect. 1. Section twenty-three of chapter twenty-eight of the Revised Laws is hereby amended by striking out the word "a", before the word "town", in the second line, and inserting in place thereof the words: — an annual, — by inserting after the word "therefor", in the eighth line, the words: — but the indebtedness so incurred shall be limited to an amount not exceeding one half of one per cent of the last preceding assessed valuation of the city or town, — and by striking out the words "commonwealth for the benefit of the", in the eleventh line, so as to read as follows: — *Section 23.* A town, by a vote of two thirds of the legal voters present and voting at an annual town meeting, or a city in which the city council consists of two branches, by a vote of two thirds of the mem- Public domain.



bers of each branch, and a city in which there is a single legislative board, by a vote of two thirds of the members thereof, present and voting thereon, may take or purchase land within their limits, which shall be a public domain, and may appropriate money and accept gifts of money and land therefor; but the indebtedness so incurred shall be limited to an amount not exceeding one half of one per cent of the last preceding assessed valuation of the city or town. Such public domain shall be devoted to the culture of forest trees, or to the preservation of the water supply of such city or town and the title thereto shall vest in the city or town in which it lies.

1913, 564, sect. 2. Said chapter twenty-eight is hereby further amended by striking out section twenty-five and inserting in place thereof the following: — *Section 25.* The city or town forester in each city or town, with one or more keepers appointed by him, shall have the management and charge of all such public domain in that city or town, and within such public domain shall have the powers of constables and police officers in towns. But a town by a vote of two thirds of the legal voters present and voting at an annual town meeting, or a city in which the city council consists of two branches, by a vote of two thirds of the members of each branch, and a city in which there is a single legislative board, by a vote of two thirds of the members thereof present and voting thereon, may place all such public domain within its limits under the general supervision and control of the state forester, who shall thereupon, upon notification thereof, make regulations for the care and use of such public domain and for the planting and cultivating of trees therein, and the city or town

Regulations regarding care of.

forester in such case and his keepers, under the supervision and direction of the state forester, shall be charged with the duty of enforcing all such regulations and of performing such labor therein as may be necessary for the care and maintenance thereof; and within such public domain shall have the powers of constables and police officers in towns.

1913, 564, sect. 3. Said chapter twenty-eight is hereby further amended by striking out section twenty-six and inserting in place thereof the following: — *Section 26.* Any such city or town may lease any building on a public domain, and shall apply all sums derived from rents or from the sale of the products of any such domain, so far as may be necessary, to the management thereof. **May lease buildings.**

1913, 564, sect. 4. Said chapter twenty-eight is hereby further amended by striking out section twenty-seven and inserting in place thereof the following: — *Section 27.* Any city or town in which such a public domain is situated may erect thereon any building for public instruction or recreation: *provided*, that if such public domain has been placed under the supervision and control of the state forester, under the provisions of this act, no such building shall be erected unless his approval shall first be obtained. **May erect buildings.**

1913, 564, sect. 5. Said chapter twenty-eight is hereby further amended by striking out section twenty-nine and inserting in place thereof the following: — *Section 29.* For the purpose of defraying the expenses incurred under the provisions of the six preceding sections any city or town may issue from time to time, and to an amount not exceeding the sum actually expended for the taking or purchase of lands for

such public domain, bonds or notes. Such bonds or notes shall be denominated on the face thereof, City or Town of , Public Domain Loan, Act of 1913; shall be payable by such annual payments, beginning not more than one year after the date thereof, as will extinguish each loan within thirty years from its date; and the amount of such annual payment of any loan in any year shall not be less than the amount of the principal of said loan payable in any subsequent year. Each authorized issue of bonds or notes shall constitute a separate loan. The bonds or notes shall bear interest at a rate not exceeding four and one half per cent per annum, payable semi-annually; and shall be signed by the treasurer and countersigned by the mayor of the city or, in the case of the town, shall be signed by the treasurer and countersigned by the selectmen. The city, by its mayor and treasurer, and the town, by its selectmen and treasurer, may sell such bonds or notes at public or private sale, upon such terms and conditions as they may deem proper, but the bonds or notes shall not be sold for less than their par value; and the proceeds shall be used only for the purposes herein specified.

How financed.

1913, 564, sect. 6. The city or town shall at the time of authorizing said loan or loans provide for the payment thereof in accordance with the foregoing provisions of this act; and when a vote to that effect has been passed by the city council, or at any annual town meeting, a sum which will be sufficient to pay the interest as it accrues on the bonds or notes issued as aforesaid by the city or town, and to make such payments on the principal as may be required under the provisions of this act, shall, without further vote, be assessed by the assessors of the city

Assessment of tax.

or town annually thereafter, in the same manner in which other taxes are assessed, until the debt incurred by said loan or loans is extinguished.

FOREST FIRE LAWS.

Forest Wardens in Cities and Towns.

R. L. 32, sect. 16, as amended, 1907, 475, sect. 1, and 1913, 600. The mayor and aldermen in cities and the selectmen in towns shall annually, in January, appoint a forest warden, and they shall forthwith give notice of such appointment to the state forester. The appointment of a forest warden shall not take effect unless approved by the state forester, and when so approved notice of the appointment shall be given by the mayor and aldermen or by the selectmen to the person so appointed and approved. Whoever having been duly appointed fails within seven days after the receipt of such notice to file with the city or town clerk his acceptance or refusal of the office shall, unless excused by the mayor and aldermen or by the selectmen, forfeit ten dollars. Nothing in this act or in any other act shall be construed to prevent the offices of tree warden, selectman, chief of fire department and forest warden from being held by the same person. Appointment of forest wardens.

1907, 475, sect. 2. The forest warden shall take precautions to prevent the spread of forest fires and the improper kindling thereof, and shall have sole charge of their extinguishment. He shall investigate the causes and extent of forest fires and the injury done thereby, the values of forest lands, the character and extent of wood-cutting operations, the prevalence of insect pests Duties of forest wardens.

injurious to forest growth, and other matters affecting the extent and condition of woodlands in his city or town, and shall report thereon to the state forester at such times and in such form as the state forester may require. He shall also post in suitable places in the city or town such warnings against the setting of forest fires and statements of the law relating thereto as may be supplied to him by the state forester. The engineers of fire departments in cities and in towns in which a fire department exists and which have so voted shall perform the duties and exercise the powers of forest wardens with respect to forest fires.

R. L. 32, sect. 20, as amended, 1907, 475, sect. 3. The forest warden may appoint deputies to assist him in the performance of his duties and may discharge the same, and he or his deputies may, if in their judgment there is danger from a forest fire, employ assistance or require any male person in their city or town between the ages of eighteen and fifty years to aid in its extinguishment or prevention, and may require the use of horses, wagons and other property adapted to that purpose, and shall keep an account of the time of all persons assisting them and a schedule of all property so used.

Appointment of deputies and requisition of men and property.

1907, 475, sect. 4. The state forester shall from moneys annually appropriated for the expenses of his office recompense the forest wardens for the time spent by them in making investigations under his direction according to the provisions of section two of this act: *provided*, that the state forester shall not be liable to make any such payment except upon the presentation of a duly itemized account, or to pay for such investigations at a rate greater than that of thirty-five cents an hour, or in excess of the appropriation available for such payment.

Compensation of forest wardens.

1907, 475, sect. 6. Forest wardens, their deputies and assistants shall not be liable for trespass while acting in the reasonable performance of their duties. **Liability for trespass.**

1907, 475, sect. 7. Whoever wilfully and maliciously tears down or destroys any notice posted under the provisions of section two of this act shall be punished by a fine of ten dollars. **Destruction of fire notices.**

1907, 475, sect. 8. The state forester may from moneys appropriated annually for the expenses of his office expend a sum not exceeding two thousand dollars in making necessary arrangements for conventions of forest wardens and in paying wholly or in part the travelling expenses to and from their towns of such forest wardens as attend this convention: *provided*, that no moneys shall be expended under authority of this section in paying the travelling expenses of any one warden to or from more than one convention in any one year; and *provided, further*, that said conventions shall be held at a place within the commonwealth. **Forestry conventions.**

Powers of Forest Wardens in Fighting Fires, and to call for Assistance.

R. L. 32, sect. 19, as amended, 1907, 475, sect. 5. If a fire occurs in woodland, two or more of the forest wardens of the town, or of a town containing woodland which is endangered by such fire, who are present at a place in immediate danger of being burned over, may set back fires and take all necessary precautions to prevent the spread of the fire. **Back fires in woodlands.**

R. L. 32, sect. 21. Whoever wilfully refuses or neglects, without sufficient cause, to assist, or to allow the use of his horses, wagons or other property as required by the preceding section, shall, for each offence, be **Penalty for refusing aid.**

punished by a fine of not less than five nor more than one hundred dollars, to be equally divided between the complainant and the town, and may also be imprisoned for not more than sixty days.

Rate of payment.

R. L. 32, sect. 23. Payment shall be made to forest wardens, to their deputies, and to the persons assisting them, and for property used under their direction at a forest fire, at a rate prescribed by the town, or in default of its action thereon, by the selectmen. No such payment shall be made until an itemized account, approved by the forest wardens under whose direction the work was done or assistance furnished, shall have been filed with the officer making payment.

Expenditures authorized.

R. L. 32, sect. 25. Money appropriated by a town under the provisions of section seventeen of chapter twenty-five, for the prevention of forest fires, and all fines received under the provisions of sections twenty-one, twenty-two and twenty-four of this chapter and section nine of chapter two hundred and eight shall be expended by the forest warden, under the supervision of the selectmen, in trimming brush out of wood roads, in preparing and preserving suitable lines for back fires or in other ways adapted to prevent or check the spread of fire; or such town may expend any portion of such money in taking in the name of the town such woodland as the selectmen, upon the recommendation of the forest warden, consider expedient for the purpose of preventing forest fires. Such taking and the payment of damages therefor or for injury to property, other than by fire or back fire, shall be governed by the laws relating to the taking of land for highways.

Setting of Fires in the Open Air.

G. A. 1916, 51, sect. 1. It shall be unlawful within any city or town for any person to set, maintain or increase a fire in the open air between the first day of March and the first day of December except by written permission of the fire prevention commissioner for the metropolitan district within the said district, or of the forest warden or chief of the fire department in other cities and towns, or, in cities that have such an official, the fire commissioner: *provided*, that debris from fields, gardens and orchards, and leaves and rubbish from yards may be burned on ploughed fields by the owners thereof, their agents or lessees; and *provided, further*, that persons above the age of eighteen years may set or maintain a fire for a reasonable purpose upon sandy land, or upon salt marshes or sandy or rocky beaches bordering upon tide water, if the fire is enclosed within rocks, metal or other non-inflammable material. In every case such a fire shall be at least two hundred feet distant from any sprout or forest land, and at least fifty feet distant from any building, and shall be properly attended until it is extinguished. The forest wardens in towns and officials performing the duties of forest wardens in cities shall cause public notice to be given of the provisions of this section and shall enforce the same. Whoever violates any provision of this section shall be punished by a fine of not more than one hundred dollars, or by imprisonment for not more than one month, or by both such fine and imprisonment.

Permit law.

G. A. 1916, 51, sect. 2. The provisions of the preceding section shall not apply to fires which may be set, maintained or increased within the metropolitan district in accordance with regulations and methods ap-

Exceptions.

proved by the fire prevention commissioner for the said district, nor to fires which may be set for the purpose of suppressing gypsy and brown tail moths in accordance with regulations and methods approved by the state forester, nor to fires set or increased within the limits of any public way by the employees of the commonwealth or of any county, city or town in the performance of public work.

G. A. 1916, 51, sect. 3. The state forester shall notify the forest warden in every town and the official performing the duties of forest warden in every city in the commonwealth of the passage of this act.

Notice.

G. A. 1916, 51, sect. 4. The state forester, the state fire warden or any duly authorized assistant of the state forester, forest wardens in towns and officials performing the duties of forest wardens in cities, or any duly appointed deputy forest warden may arrest without warrant any person found in the act of setting, maintaining or increasing a fire in violation of the provisions of this act.

Arrests.

G. A. 1916, 51, sect. 5. Section twenty-four of chapter thirty-two of the Revised Laws, and chapter two hundred and nine of the acts of the year nineteen hundred and eight, as amended by chapter two hundred and forty-four of the acts of the year nineteen hundred and eleven and by sections three and four of chapter four hundred and nineteen of the acts of the year nineteen hundred and twelve are hereby repealed.

1910, 141. It shall be unlawful within any city or town in this commonwealth for any person to liberate or fly fire balloons of any description. Whoever violates this act shall be punished by a fine of not more than one hundred dollars, or by imprisonment for not more than one month or by both such fine and imprisonment.

Fire balloons prohibited.

Disposal of Slash or Brush following Wood or Lumber Operations.

1914, 101, sect. 1. Every owner, tenant or occupant of land, and every owner of stumpage, who cuts or permits the cutting of wood or timber on woodland owned or occupied by him or on which he has acquired stumpage by purchase or otherwise, and which borders upon the woodland of another or upon a highway or railroad location, shall clear the land of the slash and brush wood then and there resulting from such cutting for such distance, not exceeding forty feet, from the woodland of such other person, highway or railroad location as the local forest warden shall determine, and within such time and in such manner as he shall determine. **40-foot fire line required.**

1914, 101, sect. 2. Any person who cuts or causes to be cut trees or brushes or undergrowth within the limits of any highway or public road shall dispose of the slash and brush wood then and there resulting from such cutting within such time and in such manner as the forest warden of the city or town wherein such cutting is done shall determine. **Disposal of brush along highway.**

1914, 101, sect. 3. Whoever neglects to comply with the directions of the forest warden with regard to the disposal of slash and brush, as provided in sections one and two of this act may be punished by a fine of not less than five dollars nor more than fifty dollars. **Penalty.**

1914, 101, sect. 4. This act shall take effect on the first day of January in the year nineteen hundred and fifteen.

Exemplary Damages for injuring Timber and Special Liability of Railroads.

R. L. 185, sect. 7. A person who without license wilfully cuts down, carries away, girdles or otherwise destroys any trees, timber, wood or underwood on the land of another shall be liable to the owner in an action of tort for three times the amount of damages assessed therefor; but if it is found that the defendant had good reason to believe that the land on which the trespass was committed was his own or that he was otherwise lawfully authorized to do the acts complained of, he shall be liable for single damages only.

Treble damages for wilfully cutting, etc.

R. L. 111, sect. 270. Every railroad corporation and street railway company shall be liable in damages to a person or corporation whose buildings or other property may be injured by fire communicated by its locomotive engines, and shall have an insurable interest in the property upon its route for which it may be so held liable, and may procure insurance thereon in its own behalf. If it is held liable in damages, it shall be entitled to the benefit of any insurance effected upon such property by the owner thereof, less the cost of premium and expense of recovery. The money received as insurance shall be deducted from the damages, if recovered before they are assessed; and if not so recovered, the policy of insurance shall be assigned to the corporation which is held liable in damages, and it may maintain an action thereon.

Railroad liability for fire.

Land adjoining Railroads, and Powers and Duties of Railroads.

1907, 431, sect. 1. Every corporation operating a steam railroad within this commonwealth shall, subject to the approval of the board of railroad commissioners, install and maintain a spark arrester on every engine in its service in which wood, coke or coal is used as fuel, and shall, between the first day of April and the first day of December in each year, keep the full width of all of its locations over which such engines are operated, to a point two hundred feet distant from the centre line on each side thereof, clear of dead leaves, dead grass, dry brush or other inflammable material, and shall not at any time leave any deposit of fire, hot ashes or live coals upon its locations in the immediate vicinity of woodlands or grass lands, and shall post in stations and other conspicuous places within its location and right of way such notices and warning placards as are furnished to it for the purpose by the state forester: *provided*, that nothing in this section shall be construed to prohibit any railroad corporation from piling or keeping upon its location or right of way crossties or other material necessary for the maintenance and operation of its railroad. **Spark arresters required; removal of inflammable material.**

1907, 431, sect. 2. Any railroad corporation may, upon giving notice according to the provisions of this section, enter upon unimproved land adjoining any location or right of way upon which it operates engines burning wood, coke or coal, and may there at its own expense and subject to the direction of the forest warden, or the officer or board having his powers, in the city or town **May clear adjoining land.**

in which the land is situated, clear such land of dead leaves, dead grass and dead wood to a distance of one hundred feet from the tracks, without thereby becoming liable for trespass: *provided*, that no railroad corporation shall, under the provisions of this section, do any acts on unimproved land outside its location or right of way, unless it has within two months given fourteen days' notice in writing by mail or otherwise to the occupant of the land, and to the owner thereof, if he resides or has a usual place of business in the city or town in which it is situated, and if the land is unoccupied and the owner does not reside or have a usual place of business in the city or town, then, unless the railroad corporation has within two months published notice of its purpose once in three successive weeks in a newspaper published in the county in which the land is situated, and unless it has within three days given at least twenty-four hours' notice to the forest warden [or the officer or board having his powers], in the city or town in which the land is situated of the location of the land which it intends to enter under the provisions of this section, and of the time at which it intends to enter the same; and *provided, further*, that no notice hereby required shall be valid unless it sets forth the provisions of this section.

Railroad fire signal.

1907, 431, sect. 3. Any engineer, conductor or other employee on a train who discovers a fire burning uncontrolled on lands adjacent to the tracks shall forthwith cause a fire signal to be sounded from the engine, which shall consist of one long and three short whistle blasts repeated several times, and shall notify the next sectionmen whom the train passes, and the next telegraph station, of the existence and location of the fire. The provisions of this section shall not affect the authority conferred upon the

board of railroad commissioners by the provisions of section one hundred and forty-eight of Part II of chapter four hundred and sixty-three of the acts of the year nineteen hundred and six.

1907, 431, sect. 4. Sectionmen or other employees of a railroad corporation who receive notice of the existence and location of a fire burning on land adjacent to the tracks shall forthwith proceed to the fire and shall use all reasonable efforts to extinguish it: *provided*, that they are not at the time employed in labors immediately necessary to the safety of tracks or to the safety and convenience of passengers and the public. **Duties of railroad employees.**

1907, 431, sect. 5. Railroad corporations shall inform their employees as to their duties under this act and shall furnish them with the appropriate facilities for reporting and extinguishing such fires. **Duties of railroad corporations.**

1907, 431, sect. 6. Nothing in this act shall be construed to give any railroad corporation power to enter upon, or to interfere in the management or care of, any public park or reservation. **Proviso as to park lands.**

1909, 394, sect. 1. Any railroad corporation which, by its servants or agents, negligently, or in violation of law, sets fire to grass lands or forest lands shall be liable to any city or town in which such fire occurs, for the reasonable and lawful expense incurred by such city or town in the extinguishment of the fire. **Railroad liability.**

1909, 394, sect. 2. Cities and towns may recover sums to which they are entitled under the provisions of this act by an action of contract in the superior court.

Town Appropriations.

R. L. 25, sect. 17. A town which accepts the provisions of this section, or has accepted the corresponding provisions of earlier laws, may appropriate money for the prevention of forest fires to an amount not exceeding one-tenth of one per cent of its valuation.

Prevention of forest fires.

1914, 262, sect. 1. Section one of chapter three hundred and ninety-eight of the acts of the year nineteen hundred and ten, is hereby amended by striking out the words "five hundred", in the second line, and inserting in place thereof the words: — seven hundred and fifty, — so as to read as follows: — *Section 1.* Every town in the commonwealth with a valuation of one million seven hundred and fifty thousand dollars or less which appropriates and expends money, with the approval of the state forester, for apparatus to be used in preventing or extinguishing forest fires or for making protective belts or zones as a defence against forest fires, shall be entitled, upon the recommendation of the state forester, approved by the governor, to receive from the treasury of the commonwealth a sum equal to one half of the said expenditure, but no town shall receive more than two hundred and fifty dollars.

Purchase of fire equipment.

1910, 398, sect. 2. A sum not exceeding five thousand dollars in any one year may be expended in carrying out the provisions of this act.

1910, 478, sect. 1. It shall be unlawful for any unnaturalized, foreign-born person to pick wild berries or flowers, or to camp or picnic upon any land of which he is not the owner, within the counties of Barnstable and Plymouth, between the first day of April and

Permit regulation of Barnstable and Plymouth counties.

the first day of December, without first obtaining written permission so to do from the owner or owners of the land. The said written permit shall not be transferable, and shall be exhibited upon demand to the forest warden, or his deputies, of the town wherein the land is located, or upon demand of any sheriff, constable, police officer or other officer authorized to arrest for crime. Failure or refusal to produce said permit upon such demand shall be prima facie evidence of a violation of this act, and any forest warden or any duly authorized deputy forest warden, police officer, sheriff or other officer authorized to arrest for crime, may arrest without warrant any person who fails or refuses to display for inspection the said permit upon the demand of any of the officials named in this act.

1910, 478, sect. 2. Whoever violates any provision of this act shall be punished by a fine of not more than fifty dollars, or by imprisonment for not more than thirty days, or by both such fine and imprisonment. Penalty.

Use of Spark Arresters on Portable Steam Sawmills, Steam Rollers, Steam Shovels and Steam Tractors.

G. A. 1917, 51, sect. 1. It shall be unlawful for any person, firm or corporation, except when the ground is covered with snow, to operate in or adjacent to forest or grass lands, any portable steam sawmill, steam roller, steam shovel, or steam tractor, which burns wood, coke, coal, or other spark-producing material as fuel, unless the same is provided with a suitable spark arrester, approved by the state forester. Use of spark arresters.

G. A. 1917, 51, sect. 2. Authority is hereby given to the state forester or his duly authorized assistants to inspect all appliances described in section one, to determine whether they are provided with suitable spark-arresters in accordance with the provisions hereof.

State forester's authority.

G. A. 1917, 51, sect. 3. Any violation of the provisions of this act shall be punished by a fine of not less than fifty nor more than one hundred dollars.

Penalty.

G. A. 1917, 51, sect. 4. This act shall not apply within the metropolitan district as defined in section one of chapter seven hundred and ninety-five of the acts of the year nineteen hundred and fourteen.

Exceptions.

Close Season for Game in Times of Drouth.

1909, 422, sect. 1. Whenever, during an open season for the hunting of any kind of game in this state, it shall appear to the governor that by reason of extreme drouth the use of firearms in the forest is liable to cause forest fires, he may, by proclamation, suspend the open season and make it a close season for the shooting of birds and wild animals of every kind for such time as he may designate, and may prohibit the discharge of firearms in or near forest land during the said time.

Governor may proclaim.

1909, 422, sect. 2. During the time designated as above by the governor, all provisions of law relating to the close season shall be in force, and whoever violates any such provisions shall be subject to the penalties prescribed therefor. In case any person shall, during a close season proclaimed as aforesaid, discharge a firearm in or near forest land, or shoot any wild animal or bird, as to which

Penalties.

or property of another are injured, shall be punished by a fine of not more than two hundred and fifty dollars.

Penalty for neglecting to extinguish fires.

R. L. 208, sect. 9. Whoever in a town which accepts the provisions of this section, or has accepted the corresponding provisions of earlier laws, sets a fire on land which is not owned or controlled by him and before leaving the same neglects to entirely extinguish such fire, or whoever wilfully or negligently suffers a fire upon his own land to escape beyond the limits thereof to the injury of another, shall be punished by a fine of not more than one hundred dollars, or by imprisonment in jail for not more than one month, or by both such fine and imprisonment; and shall also be liable for all damages caused thereby. Such fine shall be equally divided between the complainant and the town.

Cutting of timber.

R. L. 208, sect. 99, as amended, 1904, 444, sect. 1. Whoever wilfully cuts down or destroys timber or wood standing or growing on the land of another, or carries away any kind of timber or wood cut down or lying on such land, or digs up or carries away stone, ore, gravel, clay, sand, turf or mould from such land, or roots, nuts, berries, grapes or fruit of any kind or any plant there being, or cuts down or carries away sedge, grass, hay or any kind of corn, standing, growing or being on such land, or cuts or takes therefrom any ferns, flowers or shrubs, or carries away from a wharf or landing place any goods in which he has no interest or property, without the license of the owner thereof, shall be punished by imprisonment for not more than six months or by a fine of not more than five hundred dollars, and if the offence is committed on the Lord's day or in disguise or secretly in the night time the imprisonment shall not be less than five days nor the fine less than five dollars.

LAWS RELATING TO THE SUPPRESSION OF THE GYPSY AND BROWN-TAIL MOTHS.

CHAPTER 381, ACTS OF 1905, AS AMENDED BY CHAPTER 268, ACTS OF 1906, BY CHAPTER 521, ACTS OF 1907, BY CHAPTER 591, ACTS OF 1908, BY CHAPTER 150, ACTS OF 1910, BY CHAPTER 474, ACTS OF 1911, AND CHAPTER 600, ACTS OF 1913.

An Act to provide for Suppressing the Gypsy and Brown Tail Moths.

Be it enacted, etc., as follows:

SECTION 1. For the purposes of this act the pupæ, nests, eggs and caterpillars of the gypsy and brown tail moths and said moths are hereby declared public nuisances, and their suppression is authorized and required; but no owner or occupant of an estate infested by such nuisance shall by reason thereof be liable to an action, civil or criminal, except to the extent and in the manner and form herein set forth.

Gypsy moth declared nuisance.

SECTION 2.[1] The governor, by and with the consent of the council, shall appoint a superintendent for suppressing the gypsy and brown tail moths and shall determine his salary. The governor may, with the consent of the council, remove said superintendent at any time for such cause as he shall deem sufficient. In case of the death, removal or resignation of the superintendent

Appointment of superintendent.

[1] The office of superintendent was abolished by chapter 263, Acts of 1909, and the State Forester was placed in charge of the work of suppressing the gypsy and brown-tail moths. See chapter 263, Acts of 1909, printed on page 13.

reasonable means in carrying out the purposes of this act; and, in the undertakings aforesaid, may, in accordance with the provisions of this act, expend the funds appropriated or donated therefor; but no expenditure shall be made or liability incurred in excess of such appropriations and donations.

Agents may enter upon land.

The clerks, assistants and agents employed by said superintendent may at all times, in carrying out the purposes of this act, enter upon the land of the commonwealth or of a municipality, corporation or other owner or owners.

Appointment of local moth superintendent.

SECTION 4. [As amended by section 2, chapter 268, Acts of 1906; by section 1, chapter 521, Acts of 1907; by section 1, chapter 150, Acts of 1910, and chapter 600, Acts of 1913.] The mayor and aldermen in cities and the selectmen in towns shall annually in the month of January appoint a local superintendent for the suppression of the gypsy and brown tail moths. Said superintendent shall under the advice and general direction of the state forester destroy the eggs, caterpillars, pupæ and nests of the gypsy and brown tail moths within their limits, except in parks and other property under the control of the commonwealth, and except in private property, save as otherwise provided herein. The said appointments of local superintendents shall not take effect unless approved by the state forester, and when so approved, notice of the appointment shall be given by the mayor and aldermen or selectmen to the person so appointed. When any city or town shall have expended within its limits city or town funds to an amount in excess of five thousand dollars in any one fiscal year, in suppressing gypsy or brown tail moths, the commonwealth shall reimburse such city or town to the extent of fifty per cent of such excess above said five thousand dollars.

previous year shall be taken as a basis. The fiscal year for nineteen hundred and seven and for all succeeding years shall close on the thirtieth day of November.

SECTION 5. [As amended by section 3, chapter 268, Acts of 1906, by section 2, chapter 521, Acts of 1907, and chapter 474, Acts of 1911.] When, in the opinion of the superintendent, any city or town is not expending a sufficient amount for the abatement of said nuisance, or is not conducting the necessary work in a proper manner, then the superintendent shall, with the advice and consent of the governor, order such city or town to expend such an amount as the superintendent shall deem necessary, and in accordance with such methods as the superintendent, with the consent of the governor, shall prescribe: *provided*, that no city or town where the assessed valuation of real and personal property exceeds six million dollars shall be required to expend, exclusive of any reimbursement received from the commonwealth, during any one full year more than one fifteenth of one per cent of such valuation, and that no town where the assessed valuation of real and personal property is less than six million dollars shall be required to expend, exclusive of any reimbursement received from the commonwealth, during any one full year more than one twenty-fifth of one per cent of such valuation. For the purposes of this section the valuation of each previous year shall be used.

Cities and towns compelled to act.

Any city or town failing to comply with the directions of the said superintendent in the performance of said work within the date specified by him shall pay a fine of one hundred dollars a day for failure so to do; said fine to be collected by information brought by the attorney-general in the supreme judicial court for Suffolk county.

Penalty.

In case of emergency, or where there is great or immediate danger of the increase or spread of the moths due to the neglect of any city or town to comply with the terms of this act, the superintendent, with the consent of the governor, may initiate or continue the work of suppressing the moths within the limits of such city or town for such a period as the superintendent may deem necessary. The cost of such work, including that done on private estates, less any sum due from the state by way of reimbursements on account of said work, shall be certified by the superintendent to the treasurer of the commonwealth, and be collected by him as an additional state tax upon the city or town so failing to comply with the requirements of the law. The superintendent may also in case of emergency, subject to the approval of the governor, carry on wholly or in part such operations as may be necessary to check the spreading of the gypsy or brown tail moths in parks not under the control of the commonwealth, and in cemeteries, woodlands and other places of public resort. The amount to be so expended in any one year shall not exceed ten per cent of the appropriations made for the year by the state for the purpose of suppressing said moths.

Superintendent may take control.

The superintendent may also take complete control of the work of suppressing the gypsy and brown tail moths in such cities and towns as may through the proper officials request it. The cost of such work shall be certified by the superintendent to the treasurer of the commonwealth and shall be collected by him as an additional state tax upon the city or town wherein such work is performed; *provided*, that no city or town shall be required to pay more for such work than would have been its liability, as defined by section four of this act.

Cost of the work to be certified.

SECTION 6. [As amended by section 4, chapter 268, Acts of 1906, by section 2, chapter 591, Acts of 1908, and by chapter 124, Acts of 1915.] The mayor of every city and the selectmen of every town shall, on or before the first day of November in each year, and at such other times as he or they shall see fit, or as the state superintendent may order, cause a notice to be sent to the owner or owners, so far as can be ascertained, of every parcel of land therein which is infested with said moths; or, if such notification appears to be impracticable, then by posting such notice on said parcels of land, requiring that the eggs, caterpillars, pupæ and nests of said moths shall be destroyed within a time specified in the notice.

Notices to property owners.

The publication of the notice in newspapers published or circulated in the city or town at least three times during the month of October shall be deemed a compliance with the law, if in the opinion of the mayor or selectmen such publication will be a sufficient notice.

Publication of notice.

When, in the opinion of the mayor or selectmen, the cost of destroying such eggs, caterpillars, pupæ and nests on lands contiguous and held under one ownership in a city or town shall exceed one half of one per cent of the assessed value of said lands, then a part of said premises on which said eggs, caterpillars, pupæ or nests shall be destroyed may be designated in such notice, and such requirement shall not apply to the remainder of said premises. The mayor or selectmen may designate the manner in which such work shall be done, but all work done under this section shall be subject to the approval of the state superintendent.

Cost to owner.

If the owner or owners shall fail to destroy such eggs, caterpillars, pupæ or nests in accordance with the requirements

of the said notice, then the city or town, acting by the public officer or board of such city or town designated or appointed as aforesaid, shall, subject to the approval of the said superintendent, destroy the same, and the amount actually expended thereon, not exceeding one half of one per cent of the assessed valuation of said lands, as heretofore specified in this section, shall be assessed upon the said lands; and such an amount in addition as shall be required shall be apportioned between the city or town and the commonwealth in accordance with the provisions of section four of this act. The amounts to be assessed upon private estates as herein provided shall be assessed and collected, and shall be a lien on said estates, in the same manner and with the same effect as is provided in the case of assessments for street watering.

The public officer or board of any city or town designated or appointed as aforesaid, or any agent or employee of such public officer or board, may at any time enter upon any parcel of land within the limits of such city or town for the purpose of determining whether or not such parcel of land is infested with said moths, or the extent to which such parcel of land is so infested. **Public officer may enter upon land.**

SECTION 7. [As amended by section 5, chapter 268, Acts of 1906, and by section 3, chapter 521, Acts of 1907.] If, in the opinion of the assessors of a city or town, any land therein has received, by reason of the abatement of said nuisances thereon by said superintendent or by said city or town, a special benefit beyond the general advantage to all land in the city or town, then the said assessors shall determine the value of such special benefit and shall assess the amount thereof upon said land: *provided*, that no such assessment on lands contiguous and held under **Betterment.**

one ownership shall exceed one half of one per cent of the assessed valuation of said lands; and *provided*, that the owner or owners shall have deducted from such assessment the amount paid and expended by them during the twelve months last preceding the date of such assessment toward abating the said nuisances on said lands, if, in the opinion of the assessors, such amount has been expended in good faith.

Assessment a lien upon land.

Such assessment shall be a lien upon the land for three years from the first day of January next after the assessment has been made, and shall be collected under a warrant of the assessors to the collector of taxes of such city or town, in the manner and upon the terms and conditions and in the exercise of the powers and duties, so far as they may be applicable, prescribed by chapter thirteen of the Revised Laws relative to the collection of taxes.

Real estate may be redeemed.

Real estate sold hereunder may be redeemed within the time, in the manner, and under the provisions of law, so far as they may be applicable, set forth in chapter thirteen of the Revised Laws for the redemption of land sold for taxes.

Complaint of assessment.

A person aggrieved by such assessment may appeal to the superior court for the county in which the land lies, by entering a complaint in said court within thirty days after he has had actual notice of the assessment, which complaint shall be determined as other causes by the court without a jury. The complaint shall be heard at the first sitting of said court for trials without a jury after its entry; but the court may allow further time, or may advance the case for speedy trial, or may appoint an auditor as in other cases. The court may revise

each of the years nineteen hundred and five, nineteen hundred and six and nineteen hundred and seven may, in the discretion of the state superintendent, be expended by him for experimenting with parasites or natural enemies for destroying said moths, and any unexpended balance of any year may be expended in the subsequent years.

SECTION 10. Chapter two hundred and ten of the acts of the year eighteen hundred and ninety-one and sections one and two of chapter five hundred and forty-four of the acts of the year eighteen hundred and ninety-eight and section two of chapter fifty-seven of the acts of the year nineteen hundred and two, are hereby repealed.

SECTION 11. [As amended by section 6, chapter 268, Acts of 1906.] A person who wilfully resists or obstructs the superintendent or an official of a city or town, or a servant or agent duly employed by said superintendent or by any of said officials, while lawfully engaged in the execution of the purposes of this act, or who knowingly fails to comply with any of the rules or regulations issued by said superintendent, shall forfeit a sum not exceeding twenty-five dollars for each offence.

Fine for obstructing gypsy moth work.

SECTION 12. [As amended by section 4, chapter 521, Acts of 1907.] Valuations of real and personal property of each previous year shall govern the provisions of this act.

Valuations of previous year.

SECTION 13. This act shall take effect upon its passage.

abated under the provisions of this act and shall preserve for three years all written recommendations received pursuant to section two. They shall furnish the collector of taxes with a certificate of each abatement hereunder, which shall relieve him from the collection of the sum abated.

SECTION 4. This act shall take effect upon its passage.

CHAPTER 605, ACTS OF 1913.

An Act to authorize Local Moth Superintendents to furnish Arsenate of Lead to Real Estate Owners.

Be it enacted, etc., as follows:

SECTION 1. For the purpose of assisting in the extermination of gypsy and brown tail moths, the local moth superintendent in any city or town now receiving aid from the commonwealth in suppressing the said insect pests is hereby authorized to furnish, at the cost thereof, arsenate of lead to any owner of real estate situated within the limits of such city or town. Material purchased under the provisions hereof shall be used only for the suppression of gypsy and brown tail moths and only upon land of the purchaser.

SECTION 2. The amounts due for material furnished under the provisions of section one shall be charged by the local moth superintendent to the owners of private estates and shall be collected in the same manner as the amounts assessed for private work, and shall be a lien on said estates in the same manner as the assessments for private work. The amount thus charged shall be deducted from the total amount expended in each city or town in the suppression of gypsy and brown tail moths in the same manner as the amounts charged for private work, as provided for in sections six and

seven of chapter three hundred and eighty-one of the acts of the year nineteen hundred and five and its several amendments. [*Approved May 7, 1913.*

CHAPTER 404, ACTS OF 1914.

An Act to authorize Cities and Towns to suppress the Tent Caterpillar, Leopard Moth and Elm Beetle.

Be it enacted, etc., as follows:

SECTION 1. The city forester, superintendent or other person having charge of the suppression of gypsy and brown tail moths in each city and town in the commonwealth, or, where there is no such person, the tree warden, may destroy within the limits of his city or town the tent caterpillar, leopard moth and elm beetle, if authorized so to do by the mayor and city council or commission in cities, or by the selectmen in towns.

SECTION 2. For the purposes of this act the city forester or other officer designated in section one of this act may enter upon private land, and the owners of private land may be taxed for work done under the provisions of section one of this act in the manner provided by sections six and seven of chapter three hundred and eighty-one of the acts of the year nineteen hundred and five and acts in amendment thereof and in addition thereto: *provided, however*, that nothing contained in this act shall require the commonwealth to pay any part of any such expense, other than for the suppression of the gypsy and brown tail moths, that no land shall be assessed under the provisions of this act which has been assessed the maximum amount provided by said sections six and seven and amendments thereof for the suppression of

the gypsy and brown tail moths, and that the aggregate assessment on any parcel of private land for the suppression of the tent caterpillar, leopard moth, elm beetle and gypsy and brown tail moths shall not exceed the maximum provided by said sections six and seven and the amendments thereof.

SECTION 3. This act shall take effect upon its passage. [*Approved April 23, 1914.*

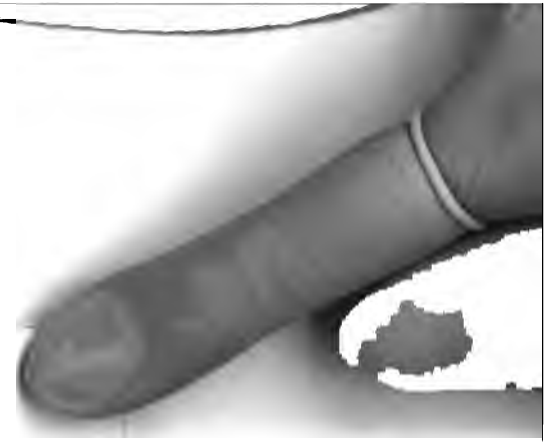
CHAPTER 171, ACTS OF 1915.

An Act to authorize Cities and Towns to purchase Arsenate of Lead for the Purpose of Suppressing Insect Pests.

Be it enacted, etc., as follows:

SECTION 1. For the purpose of assisting in the extermination of insect pests the city forester, local moth superintendent or tree warden in any city or town may obtain from the state forester at the cost thereof, arsenate of lead. Material purchased under the provisions hereof shall be used only for the suppression of gypsy and brown-tail moths, the tent caterpillar, leopard moth and elm beetle, and only upon lands owned or controlled by the city or town. The cost of said material shall be certified by the state forester to the treasurer of the commonwealth, and shall be collected by him as an additional state tax upon the city or town making such purchase.

SECTION 2. This act shall take effect upon its passage. [*Approved April 16, 1915.*



A primeval white pine. Height, 150 feet; diameter, breast high, 48 inches; contents, 5,000 board feet. (Photograph by R. T. Fisher.)

2

FOREST MENSURATION

TABLES FOR MEASURING LOGS, TREES AND THE GROWTH OF STANDS

BY

THE MASSACHUSETTS STATE FORESTER

H. O. COOK, Chief Forester

THE HARVARD FOREST

R. T. FISHER, Director

PUBLISHED BY

THE COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF CONSERVATION

W. A. L. BAZELEY, Commissioner

BOSTON

WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS

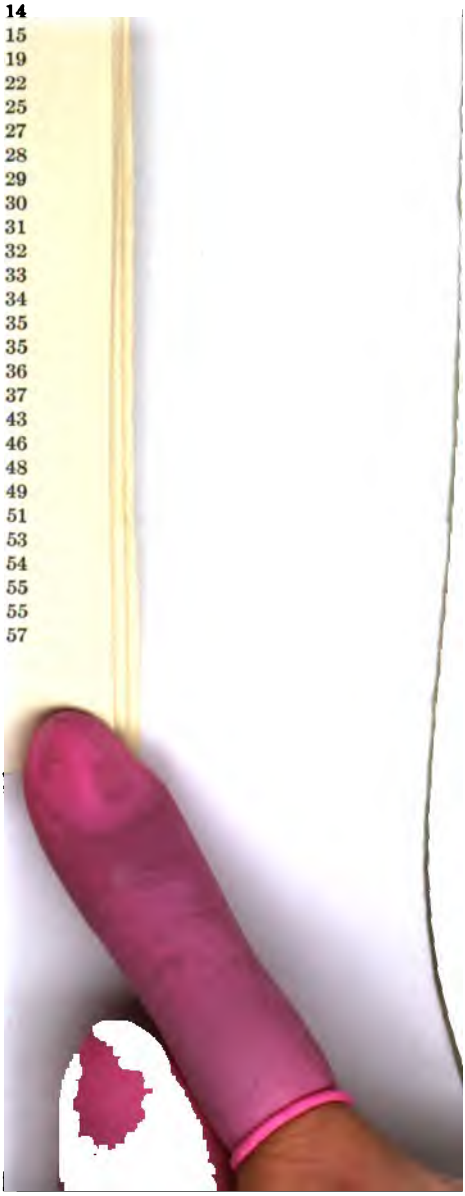
32 DERNE STREET

1921

Publication of this Document
approved by the
Supervisor of Administration.

CONTENTS.

	PAGE
Introduction	5
Board foot, the	7
Log rules	8
Log rule for oak	10
Log rule for pine	11
Log rule for chestnut	14
Log rule for yellow birch	15
Log rule for beech	19
Log rule for sugar maple	22
Volume tables	25
Tree caliper	27
Volume table for oak	28
Volume table for pine (in board feet)	29
Volume table for pine (in cords)	30
Volume table for pine (in cubic feet)	31
Volume table for chestnut (in cords)	32
Volume table for chestnut (in board feet)	33
Volume table for red maple (in cords)	34
Volume table for red maple (in cubic feet)	35
Per cent solid wood in maple cord wood	35
Number of maple trees required to yield one cord	36
Volume table for yellow birch	37
Volume table for sugar maple	43
Volume table for beech	46
Yield tables	48
Yield tables for better hardwoods (in cubic feet and cords)	49
Yield tables for better hardwoods (in board feet and cords)	51
Yield tables (inferior hardwoods)	53
Yield table for pine	54
Yield from thinnings	55
Growth	55
Growth tables (growth in volume)	57



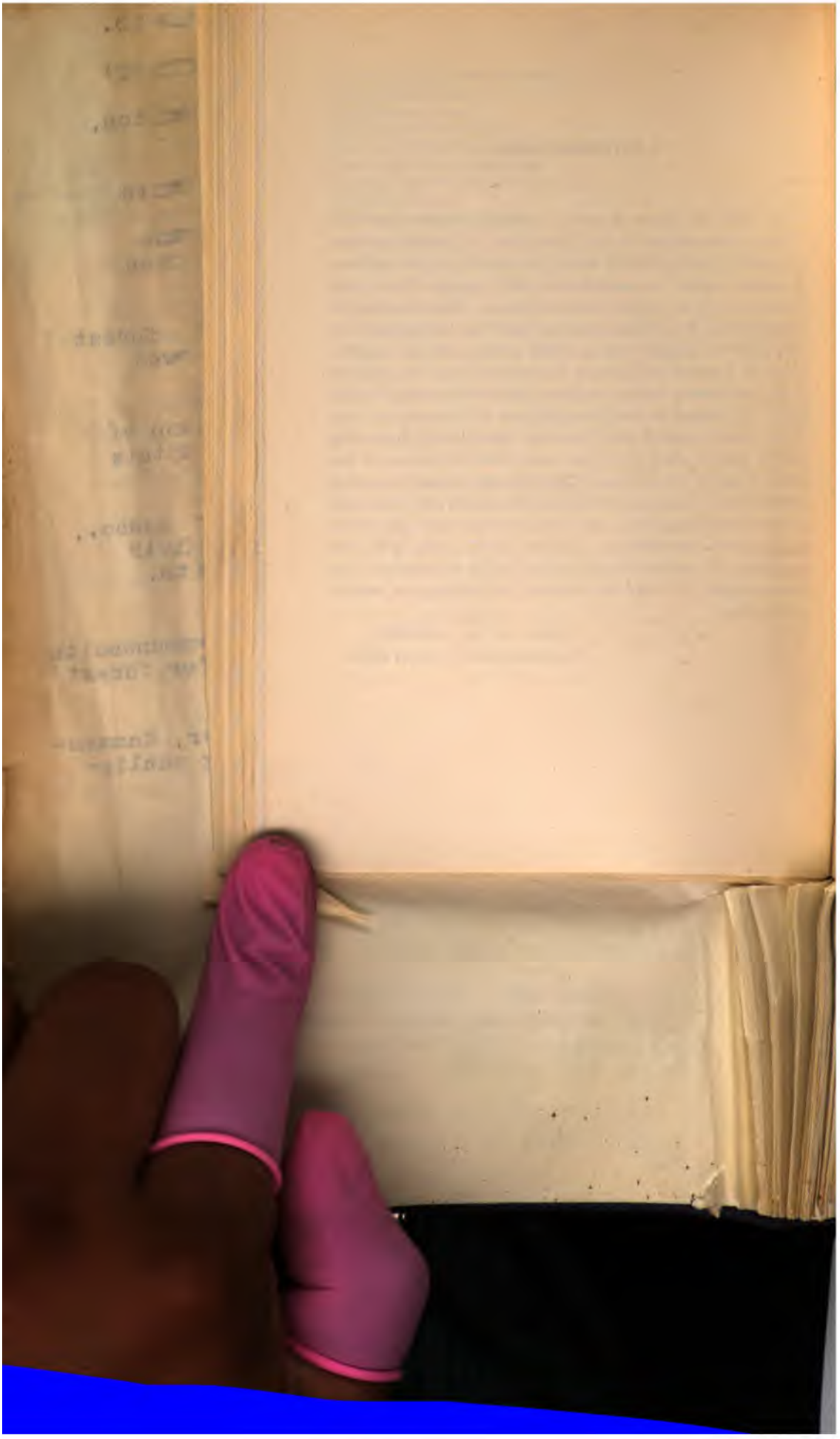
PAGE

Growth tables (growth in height) 58
Growth tables (for white spruce) 59
Miscellaneous notes 59
Sawing boards and planks 60
Band saw versus circular 61
Round edge versus square edge 62
Squaring round-edged boards 64
Equivalent factors 66
Measurement of fuel 68

INTRODUCTION.

In 1908 the State Forester published, under the title "Forest Mensuration of the White Pine," a booklet containing most of the data on the white pine included in this bulletin. A second edition was published in 1911, and as that is now exhausted a third edition seems necessary. Since the original investigation of the white pine was made the Department has also collected similar data on other species, and the Department of Forestry at Harvard University has in its research work published a large amount of information along similar lines. It seemed to the Commissioner of Conservation that these tables, many of which are very valuable and interesting to the forest owner, should be made available for use of the general public by including them with the original material. Director R. T. Fisher of the Harvard Forest has very graciously accepted this suggestion, and has turned his material over to us for use in this bulletin. To Mr. H. O. Cook, M.F., the author of the original bulletin on white pine mensuration, has been assigned the task of compiling and editing the present publication.

WM. A. L. BAZELEY,
Commissioner of Conservation.



FOREST MENSURATION.

THE BOARD FOOT.

The unit of measure on which sawed lumber is almost universally sold in the United States is the board foot, which is a board 12 inches square and 1 inch thick. In southeastern Massachusetts, however, they have a practice of sawing lumber five-eighths inch thick, and they call a board foot a board which is 12 inches square and only five-eighths inch in thickness. The variation is often the cause of some misunderstanding by those who are ignorant of the local system. The number of board feet in any given piece of lumber is obtained by multiplying the product of the width and thickness in inches by the length in feet, and dividing by 12. For instance, a plank 8 inches wide, 2 inches thick, and 12 feet long will figure as follows: $\frac{2' \times 8'' \times 12'}{12} = 16$ board feet. Professional scalers have a board rule which is laid across the width of a board, and on the rule are given the board-feet contents of that particular width and length, provided it is 1 inch thick. If, however, it happens to be thicker, say $1\frac{1}{2}$ inches instead of 1, the scale as indicated on the rule must be increased 50 per cent to allow for the additional thickness. The scaling of square-edge lumber with straight and parallel sides is a mere mechanical process, but it happens that most of our native lumber cut in Massachusetts is sawed through and through, with the bark left on the edges. Such lumber is narrower on one face than on the other, and the board is

narrower at one end than at the other. (See diagrams on page 63.) The rule for scaling this form of lumber provides that it must be scaled on the narrow face inside the bark at the place of average width. The determination of the place of average width is left to the scaler, so that it means that a man measuring this kind of lumber must have good judgment and be without bias.

LOG RULES.

The contents of round logs are usually expressed in terms of board feet, and a log rule purports to show the number of board feet that can be sawed from a log of given length and diameter. Log rules are of two classes. The first class may be called the theoretical rules, which are based on geometrical or mathematical formulæ, where given values are allowed for lumber that must be wasted in slabs and saw kerf, and the remainder figured as usable boards. There are more than forty such rules in use in America, no two of which give the same value to the same log. As they are nearly all meant to apply to square-edge lumber they have no value for use under our local conditions. The second class is made from mill tallies; that is, logs are followed through the mill and the number of board feet each log actually sawed out noted. The results of many logs are then averaged. The log rules printed in this book were constructed in this fashion, and they are commended for use in all transactions for buying or selling logs where the ultimate product is to be in the form for which the log rule is constructed. They are based on conditions of lumbering and sawing found in this State, and are the results of averaging the saw bill of many mills, most of them of the portable kind, having circular saws cutting a $\frac{1}{4}$ inch kerf, unless otherwise noted.

In addition to log rules based on board feet we have in use in northern Massachusetts, and also to some extent in southern Massachusetts, the so-called caliper cord. The basis of this rule is the cylindrical foot, — a cylinder a foot in diameter and a foot in length. It will be seen that by placing four of these end to end one has a stick 4 feet long and 1 foot in diameter. Eight such sticks placed side by side and four ranks deep will occupy a space 8 feet by 4 feet by 4 feet, or a cord, hence 128 cylindrical feet equal a cord. By means of a special caliper measure used on the middle of the log the number of cylindrical feet in that log are determined, and 128 such feet are called a cord.

There is a variation of this caliper cord rule very considerably used, called the Humphrey rule, in which the cylindrical foot unit is somewhat larger than 1 foot, and so proportioned that 100 instead of 128 cylindrical feet will occupy 128 cubic feet of space. This makes it possible to express the volumes of the logs in decimal parts of a cord, and it is therefore very convenient to use. The resulting sum is exactly the same as the ordinary caliper cord rule.

TABLE NO. 1. — *Mill Tally Log Rule for Mixed Oak.*

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	LENGTH OF LOG (FEET).					
	6	8	9	10	12	16
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
6, ...	6	10	12	14	17	23
7, ...	10	15	18	20	25	33
8, ...	15	21	24	27	34	46
9, ...	20	27	33	37	45	61
10, ...	26	38	43	49	58	77
11, ...	33	47	54	60	72	94
12, ...	39	56	64	73	87	113
13, ...	46	66	76	88	104	134
14, ...	54	77	89	104	122	154
15, ...	62	89	103	121	140	175
16, ...	69	101	118	139	158	195
17, ...	77	114	132	156	176	215
18, ...	86	127	147	174	195	234
19, ...	94	140	164	192	214	254
20, ...	–	–	–	–	–	–

Based on 1,100 logs sawed into 1¼-inch, 2-inch, 2½-inch, and 3-inch round-edge plank. Constructed by Massachusetts State Forester.

TABLE NO. 2. — *Mill Tally Log Rule for White Pine.*

DIAMETER, OUTSIDE BARK AT MIDDLE OF LOG (INCHES).	LENGTH OF LOG (FEET).			
	10	12	14	16
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
5.	8	12	16	20
6.	12	16	20	24
7.	15	20	25	30
8.	20	26	31	36
9.	26	33	39	45
10.	34	41	49	57
11.	42	51	60	70
12.	51	62	75	86
13.	61	73	88	105
14.	71	85	103	120
15.	82	99	120	140
16.	93	116	137	162
17.	104	132	156	184
18.	116	148	175	206
19.	130	166	195	230
20.	–	185	218	257
21.	–	204	240	285
22.	–	226	266	312
23.	–	250	292	–
24.	–	275	322	–
25.	–	296	350	–

Based on 1,200 logs sawed principally into 1-inch and 1¼-inch round-edge lumber. Constructed by State Forester.

TABLE NO. 3. — *Mill Tally Log Rule for White Pine.*

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	LENGTH OF LOG (FEET).			
	10	12	14	16
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
4, ...	9	13	17	21
5, ...	13	17	21	26
6, ...	17	22	27	32
7, ...	23	29	35	40
8, ...	30	37	44	51
9, ...	39	47	55	64
10, ...	48	58	68	79
11, ...	58	70	82	98
12, ...	69	83	97	115
13, ...	80	96	113	136
14, ...	92	111	131	158
15, ...	104	129	150	180
16, ...	117	146	170	205
17, ...	131	165	192	230
18, ...	–	184	220	256
19, ...	–	206	243	288
20, ...	–	230	272	–
21, ...	–	255	300	–
22, ...	–	280	330	–
23, ...	–	310	–	–
24, ...	–	340	–	–

Based on 1,200 logs sawed principally into 1-inch and 1¼-inch round-edge lumber. Constructed by State Forester.

TABLE NO. 4. — *Mill Tally Log Rule for White Pine.*

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	LENGTH OF LOG (FEET).		
	8	10	12
	Ft. B. M.	Ft. B. M.	Ft. B. M.
3,	4	5	6
4,	6	8	10
5,	10	12	15
6,	14	17	21
7,	18	22	28
8,	24	29	37
9,	30	37	47
10,	38	47	58
11,	45	57	70
12,	54	69	85
13,	63	82	100
14,	73	95	115
15,	85	109	133
16,	99	125	152
17,	113	141	173
18,	129	158	193
19,	145	178	215
20,	164	198	236
21,	–	217	257

The mean or average of seven individual tables constructed on the Harvard Forest in different years and based on the actual volume in board feet sawed from 3,500 logs, as follows: 8-foot logs, 714; 10-foot logs, 564; 12-foot logs, 2,222. Sawing: 60 per cent, 2½-inch round-edge; remainder, 1-inch square-edge and 1-inch sidings.

TABLE No. 5. — *Mill Tally Log Rule for Chestnut.*

Diameter, Inside Bark at Small End (Inches).	Length of Log (Feet).		
	8	10	12
	Ft. B. M.	Ft. B. M.	Ft. B. M.
3,	3	4	6
4,	7	8	10
5,	11	12	15
6,	15	17	22
7,	20	23	30
8,	26	30	39
9,	33	39	50
10,	41	49	62
11,	50	60	77
12,	61	74	91
13,	72	88	106
14,	84	102	124
15,	96	118	142
16,	109	134	159
17,	123	152	178
18,	–	168	197
19,	–	186	219
20,	–	205	241
21,	–	–	267
22,	–	–	294

The mean or average of three individual tables constructed on the Harvard Forest in different years and based on the actual volume in board feet sawed from 934 logs, as follows: 8-foot logs, 169; 10-foot logs, 143; 12-foot logs, 622. Sawing: 50 per cent, 1¼-inch round-edge; remainder, 1-inch round-edge and 1-inch sidings.

TABLE No. 6. — *Graded Mill Tally Log Rule for Yell*
Birch — Continued.

12-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Tot
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B
7, . . .	–	–	–	–	10	10	2
8, . . .	–	–	–	5	10	15	3
9, . . .	–	–	–	10	15	15	4
10, . . .	–	–	5	15	15	15	5
11, . . .	–	–	5	20	15	20	6
12, . . .	–	5	10	20	15	20	7
13, . . .	5	5	15	20	15	20	8
14, . . .	5	5	20	25	15	30	10
15, . . .	10	5	25	25	15	30	11
16, . . .	15	10	30	30	15	30	13
17, . . .	25	10	40	30	15	30	15
18, . . .	30	15	45	30	20	30	17
19, . . .	40	15	50	30	15	30	18
20, . . .	50	15	55	30	20	30	20
21, . . .	60	20	60	30	20	30	22
22, . . .	70	25	65	35	20	35	25
23, . . .	85	30	70	30	20	35	27
24, . . .	90	30	70	35	25	40	29

The merchantable length of the trees was seldom over 32 feet; practicall
logs were taken above the first branches. The percentage of 1, 2 and 3 log t
was as follows: —

	Birch.	Maple.	Beech
1-log trees, ...	23	22	37
2-log trees, ...	62	60	58
3-log trees, ...	15	18	5

TABLE No. 6. — *Graded Mill Tally Log Rule for Yellow Birch* — Continued.

14-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7. . . .	–	–	–	5	15	10	30
8. . . .	–	–	–	10	15	15	40
9. . . .	–	–	–	10	15	15	40
10. . . .	–	–	5	15	15	15	50
11. . . .	–	–	10	20	20	20	70
12. . . .	–	5	10	25	20	20	80
13. . . .	5	5	20	25	20	25	100
14. . . .	10	5	25	25	20	25	110
15. . . .	15	5	35	30	20	25	130
16. . . .	15	10	40	35	20	30	150
17. . . .	20	15	50	35	20	30	170
18. . . .	35	15	55	35	20	30	190
19. . . .	45	20	70	35	20	30	220
20. . . .	60	20	75	35	20	30	240
21. . . .	75	25	80	35	25	30	270
22. . . .	90	25	90	30	25	30	290
23. . . .	105	25	95	40	25	30	320
24. . . .	120	25	95	40	25	35	340

Nearly one-half of the logs cut were defective or abnormal in some particular, as shown in the following table: —

	BIRCH.				
	Volume reduced 10 Per Cent and Less.	Volume reduced 10–20 Per Cent.	Volume reduced 20–30 Per Cent.	Volume reduced 30 Per Cent and Over.	Total Defective Logs.
Butt defects, . . .	54	27	30	39	150
Top defects, . . .	26	21	10	15	72
Crook, . . .	102	45	32	28	207
Sweep, . . .	24	45	21	10	100
Knotty, . . .	47	14	6	5	72
Seam, . . .	0	6	3	4	13
Shake, . . .	7	8	6	3	24
Miscellaneous, . . .	11	5	1	3	20
Total, . . .	271	171	109	107	658

Defective, 43 per cent.

TABLE No. 6. — *Graded Mill Tally Log Rule for Yello Birch* — Concluded.

16-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B.
7, . . .	–	–	–	5	15	10	30
8, . . .	–	–	–	10	15	15	40
9, . . .	–	–	–	15	20	15	50
10, . . .	–	–	5	15	20	20	60
11, . . .	–	–	10	20	20	20	70
12, . . .	5	5	15	25	20	20	90
13, . . .	5	5	20	30	25	25	110
14, . . .	10	5	35	30	25	25	130
15, . . .	15	10	45	30	25	25	150
16, . . .	25	10	55	35	25	30	180
17, . . .	30	15	60	40	25	30	200
18, . . .	40	15	70	40	25	30	220
19, . . .	55	20	80	40	25	30	250
20, . . .	70	25	90	40	25	30	280
21, . . .	90	25	100	40	25	30	310
22, . . .	110	25	110	40	25	30	340
23, . . .	130	25	115	40	25	35	370
24, . . .	145	25	120	40	25	35	390

TABLE NO. 7. — *Graded Mill Tally Log Rule for Beech.*

10-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8.	–	–	5	25	30
9.	–	–	10	20	30
10.	–	10	10	20	40
11.	–	10	15	25	50
12.	–	15	15	30	60
13.	5	20	15	30	70
14.	10	25	15	30	80
15.	15	25	15	35	90
16.	20	30	20	40	110
17.	30	35	20	45	130

Nearly one-half of the logs cut were defective or abnormal in some particular, as shown in the following table: —

	BEECH.				
	Volume reduced 10 Per Cent and Less.	Volume reduced 10–20 Per Cent.	Volume reduced 20–30 Per Cent.	Volume reduced 30 Per Cent and Over.	Total Defective Logs.
Butt defects,	16	8	1	4	29
Top defects,	8	4	6	2	20
Crook,	69	29	17	6	121
Sweep,	33	19	8	9	69
Knotty,	29	7	3	3	42
Seam,	8	5	2	6	21
Shake,	–	–	–	–	–
Miscellaneous,	7	4	5	2	18
Total,	170	76	42	32	320

Defective, 51 per cent.

TABLE No. 7. — *Graded Mill Tally Log Rule for Beech* — Continued.

12-Foot Logs.

Diameter, Inside Bark at Small End (Inches).	Grade of Lumber.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8,	–	–	5	25	30
9,	–	5	10	25	40
10,	–	10	10	30	50
11,	–	15	15	30	60
12,	5	15	15	35	70
13,	10	20	15	35	80
14,	15	25	15	35	90
15,	20	30	20	40	110
16,	30	35	20	45	130
17,	40	40	20	50	150

14-Foot Logs.

8,	–	–	5	25	30
9,	–	5	10	25	40
10,	–	10	10	30	50
11,	–	20	15	35	70
12,	5	20	15	40	80
13,	15	25	20	40	100
14,	20	30	20	40	110
15,	25	35	20	50	130
16,	35	40	25	50	150
17,	45	45	25	55	170

For yellow birch a comparison was made of the contents of nondefective butt logs, nondefective top logs, and the average of all logs. This showed that the difference in volume due both to defect and position in the tree was negligible for logs under 12 inches in diameter at the small end, while for logs 12 inches and over in diameter it amounted to about 9 per cent of the volume of the sound butt logs. It was less than 6 per cent for logs from 12 to 16 inches in diameter, and a little less than 11 per cent for 21 to 24 inch logs. The difference due to position in the tree between sound normal top and butt logs varied from about 3 per cent of the volume of the 12 to 16 inch butt logs to about 10 per cent of the 21 to 24 inch butt logs.

In the table for yellow birch it will be noted that the 10-foot logs show a greater proportion of the poorer grades than do the longer logs. This is particularly noticeable in the No. 1 common red and the No. 2 common grades, and is due especially to the fact that the majority of the 10-foot logs were top logs and hence knotty and of inferior quality.

TABLE No. 7. — *Graded Mill Tally Log Rule for Beech* — Concluded.

16-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8.	–	–	10	30	40
9.	–	10	10	30	50
10.	–	10	15	35	60
11.	–	20	20	40	80
12.	5	25	20	40	90
13.	15	30	20	45	110
14.	20	35	25	50	130
15.	30	40	25	55	150
16.	40	45	25	60	170
17.	55	55	25	65	200

While they can be applied with substantial accuracy only to conditions similar to those under which they were made, these tables may perhaps be used in other regions by carefully studying and comparing defects, methods of utilisation, etc., and applying suitable converting factors. With these precautions graded volume tables can be constructed by combining the graded log rules here given with tables which show the average taper of trees. Graded volume tables actually constructed from these tables will be found on pages 37 to 47. They are not based upon taper tables but on felled trees (yellow birch, 505; sugar maple, 301; beech, 220).

TABLE NO. 8. — *Graded Mill Tally Log Rule for Sugar Maple.*

10-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	5	15	20
8,	–	–	10	20	30
9,	–	–	10	20	30
10,	–	10	10	20	40
11,	5	15	10	20	50
12,	5	20	15	20	60
13,	10	25	10	25	70
14,	15	25	15	25	80
15,	25	30	15	30	100
16,	35	30	15	30	110
17,	50	30	15	35	130
18,	60	30	15	35	140
19,	75	35	15	35	160
20,	90	40	15	35	180

Nearly one-half of the logs cut were defective or abnormal in some particular, as shown in the following table: —

	MAPLE.				
	Volume reduced 10 Per Cent and Less.	Volume reduced 10–20 Per Cent.	Volume reduced 20–30 Per Cent.	Volume reduced 30 Per Cent and Over.	Total Defective Logs.
Butt defects,	39	9	12	14	74
Top defects,	29	15	15	8	67
Crook,	46	22	24	7	99
Sweep,	37	17	12	3	69
Knotty,	62	15	10	4	91
Seam,	4	2	4	5	15
Shake,	–	–	–	–	–
Miscellaneous,	3	1	2	6	12
Total,	220	81	79	47	427

Defective, 45 per cent.

TABLE NO. 8. — *Graded Mill Tally Log Rule for Sugar Maple* — Continued.

12-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7.	–	–	5	15	20
8.	–	5	5	20	30
9.	–	10	10	20	40
10.	–	10	10	20	40
11.	5	15	10	20	50
12.	10	20	15	25	70
13.	15	25	15	25	80
14.	20	30	15	25	90
15.	30	35	15	30	110
16.	45	35	15	35	130
17.	60	35	15	40	150
18.	70	35	15	40	160
19.	85	40	15	40	180
20.	100	40	20	40	200

14-Foot Logs.

7.	–	–	10	20	30
8.	–	5	10	25	40
9.	–	10	10	20	40
10.	–	15	10	25	50
11.	5	20	10	25	60
12.	10	25	15	30	80
13.	15	30	15	30	90
14.	25	35	20	30	110
15.	35	40	20	35	130
16.	50	40	20	40	150
17.	60	40	20	40	160
18.	80	40	20	40	180
19.	100	45	20	45	210
20.	120	45	20	45	230

See footnote under Graded Mill Tally Log Rule for Yellow Birch.

TABLE No. 8. — *Graded Mill Tally Log Rule for Su*
Maple — Concluded.

16-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Tot
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B
7,	–	–	10	20	3
8,	–	5	10	25	4
9,	–	10	15	25	5
10,	–	15	15	30	6
11,	5	20	15	30	7
12,	10	30	20	30	9
13,	20	35	20	35	11
14,	30	40	20	40	13
15,	45	45	20	40	15
16,	60	45	20	45	17
17,	75	50	20	45	19
18,	90	50	25	45	21
19,	100	50	25	45	23
20,	140	55	25	50	27

VOLUME TABLES.

A volume table gives the number of board feet or other units that one may expect to obtain from a tree of given dimensions, the given dimensions being the diameter breast high and the total height, or the used length of the trunk of the tree. Many lumbermen use the diameter at the top of the stump as the diameter of the tree, but this is unsatisfactory, because stump heights vary, and also there is usually a considerable swell at the base which varies greatly in trees of the same general size. Breast-high diameter (about 4½ feet above the ground) is at a convenient elevation for actual use, and it avoids the two objections to stump diameters just enumerated. In the pine and chestnut volume tables it is presumed that all the bole above a 6-inch stump and below a top diameter of 4 inches is used.

The utility of volume tables lies in estimating the quantity of standing timber. A dozen different methods of estimating can be suggested in which volume tables play a part, and which vary in accuracy. The most accurate and best method for small lots is to caliper every tree, obtaining thus their diameter and number. Then obtain the average height of the stand, if it is more or less uniform, or otherwise divide the trees into two or more diameter classes, and get the average height of each class. From the volume tables obtain the volume of each diameter class, multiply by the number of trees, and add all together to make the volume of the stand.

A second method is to select a "sample plot" of kn
area, preferably one-quarter acre. A circle with a 59-
radius, or a square 104 feet on a side, encloses one-qua
acre. Caliper all trees on this plot, and obtain the volum
above. The total volume will be to this volume as the t
area is to the area of the sample plot.

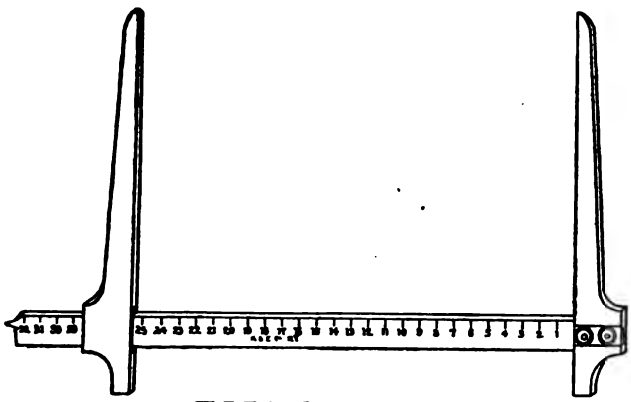
A simple, but yet more uncertain, method is to count
trees on the lot, pick five or six which appear to be aver
scale these by the volume table to obtain the volume of
average tree, and multiply this amount by the total numb
trees. If one is not careful in selecting his average trees
error is multiplied many times, so that this method is
highly recommended.

The simplest although not the least laborious way of get
at the height of a stand is to cut down an average tree
measure it with tape. Fallen trees can often be found or
ground. Any instrument that reads angles, a measuring t
and the application of a little trigonometry will give the de
results. There are several instruments constructed to
by direct reading the heights of trees.

There is a method of obtaining the height of a tree th
fairly simple and requires no instrument but a stick w
when stuck in the ground, will come to the level of your
Set this stick in the ground at such a distance from the
of the tree to be measured so that when you lie on the gr
with your feet at the stick the top of the tree and the t
the stick are in line. The distance between your head
the base of the tree is equal to its height.

A caliper of great convenience for use in connection
volume tables and log scales mentioned in this book co
of a beam 36 inches long and graduated into inches and te
At the left end is a rigid arm set at right angles to the b

while another arm is so fixed that it will slide back and forth at will. These calipers can be purchased from Keuffel & Esser Company, of Jersey City, N. J.



TREE CALIPER

The volume tables for pine are of three kinds, — first, a table showing quantities in board feet; second, one showing volumes in caliper cords; and third, one showing volumes in solid cubic feet. The volume table for oak is classed, not on diameter and total height, but on diameter breast high and merchantable length. By merchantable length we mean that portion of the bole that can be cut into saw logs. In the table on chestnut only the volumes in board feet are given.

TABLE No. 9. — *Volume Table for Mixed Oak.*

DIAMETER, BREAST HIGH (INCHES).	MERCHANTABLE HEIGHT (FEET).					
	20	25	30	35	40	45
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8, ...	26	33	40	47	54	61
9, ...	39	47	55	62	70	78
10, ...	54	63	73	81	90	99
11, ...	71	81	92	101	111	122
12, ...	88	100	112	123	133	145
13, ...	108	121	134	147	160	175
14, ...	130	145	160	175	190	206
15, ...	155	172	188	205	224	244
16, ...	183	202	220	240	260	281
17, ...	213	233	253	274	297	323
18, ...	244	265	287	310	337	366
19, ...	275	297	322	347	377	410
20, ...	306	331	357	385	420	454
21, ...	337	364	394	425	461	499
22, ...	370	397	430	465	503	543
23, ...	401	430	465	505	545	586

Data from North Andover and Middleborough based on 570 trees sawed into 1¼-inch, 1¾-inch, 2¼-inch, 2¾-inch and 3-inch round-edge plank (portable mill operation). Constructed by State Forester.

TABLE NO. 10. — *Volume Table for White Pine.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT (FEET).							
	30	40	50	60	70	80	90	100
	Ft.B.M.	Ft.B.M	Ft.B.M.	Ft.B.M.	Ft.B.M.	Ft.B.M.	Ft.B.M.	Ft.B.M.
5. . .	10	–	–	–	–	–	–	–
6. . .	15	20	30	–	–	–	–	–
7. . .	20	30	40	50	65	–	–	–
8. . .	25	35	50	65	85	–	–	–
9. . .	30	45	60	80	105	115	–	–
10. . .	40	55	75	95	125	145	–	–
11. . .	–	65	90	115	145	170	200	230
12. . .	–	75	105	135	165	200	230	260
13. . .	–	85	120	155	190	235	260	295
14. . .	–	100	140	175	215	265	300	335
15. . .	–	115	160	200	245	300	340	375
16. . .	–	–	180	230	275	335	380	420
17. . .	–	–	–	260	310	370	425	470
18. . .	–	–	–	295	350	410	475	530
19. . .	–	–	–	335	390	455	530	600
20. . .	–	–	–	380	435	505	580	660
21. . .	–	–	–	–	480	550	635	720
22. . .	–	–	–	–	520	595	680	780
23. . .	–	–	–	–	565	640	730	835
24. . .	–	–	–	–	600	690	780	890
25. . .	–	–	–	–	645	740	830	940
26. . .	–	–	–	–	–	–	885	995
27. . .	–	–	–	–	–	–	940	–

Based on 1,300 trees scaled from rules made by mill tallies. Constructed by State Forester.

TABLE No. 11. — *Volume Table, in Caliper Cords, for White Pine.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT (FEET).						
	30	40	50	60	70	80	90
	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
5, ...	.03	–	–	–	–	–	–
6, ...	.03	.04	.05	–	–	–	–
7, ...	.04	.05	.07	.09	–	–	–
8, ...	.05	.07	.09	.11	.13	–	–
9, ...	.07	.09	.11	.13	.16	–	–
10, ...	–	.11	.13	.16	.19	.22	–
11, ...	–	.13	.16	.19	.23	.26	.30
12, ...	–	.15	.19	.22	.27	.31	.35
13, ...	–	.17	.22	.26	.31	.36	.40
14, ...	–	–	.25	.30	.34	.41	.45
15, ...	–	–	.28	.34	.40	.46	.51
16, ...	–	–	.32	.38	.44	.52	.58
17, ...	–	–	–	.42	.49	.58	.64
18, ...	–	–	–	.47	.55	.64	.71
19, ...	–	–	–	.51	.60	.70	.79
20, ...	–	–	–	.55	.66	.77	.87
21, ...	–	–	–	–	.72	.85	.95
22, ...	–	–	–	–	.78	.92	1.04
23, ...	–	–	–	–	.84	1.01	1.13
24, ...	–	–	–	–	.90	1.08	1.22
25, ...	–	–	–	–	.97	1.16	1.32
26, ...	–	–	–	–	–	–	1.42
27, ...	–	–	–	–	–	–	1.51

Constructed by State Forester.

TABLE NO. 12. — *Volume Table for White Pine.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT (FEET).						
	30	40	50	60	70	80	90
	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.
5.	1.8	–	–	–	–	–	–
6.	2.6	3.3	4.3	–	–	–	–
7.	3.4	4.4	6.1	7.7	–	–	–
8.	4.5	6.0	7.8	9.8	12.0	–	–
9.	5.9	7.7	10.0	12.0	15.0	–	–
10.	–	9.6	12.0	15.0	17.9	20.9	–
11.	–	11.6	14.6	17.9	21.4	24.9	28.7
12.	–	13.9	17.6	21.1	25.3	29.8	33.7
13.	–	16.2	20.4	24.8	29.2	34.7	38.7
14.	–	–	23.7	28.7	32.5	39.6	43.6
15.	–	–	26.8	32.6	37.9	44.5	49.5
16.	–	–	30.5	36.5	42.3	49.8	55.9
17.	–	–	–	40.3	47.2	56.7	62.3
18.	–	–	–	44.6	52.6	61.5	69.1
19.	–	–	–	49.0	57.9	67.8	76.9
20.	–	–	–	52.9	63.2	74.7	84.8
21.	–	–	–	–	69.1	82.0	92.6
22.	–	–	–	–	74.9	89.3	101.4
23.	–	–	–	–	81.3	98.1	110.8
24.	–	–	–	–	87.1	104.9	119.0
25.	–	–	–	–	94.0	112.6	128.8

Constructed by State Forester. Volume outside bark up to a 4-inch top.

TABLE NO. 13. — *Volume of Chestnut in 6 by 8 Inch T*
and Additional Cordwood.

DIAMETER, BREAST HIGH (INCHES).	HEIGHT (FEET).									
	50		60		70		80		90	
	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.	Ties.	Cor
10, . .	1	.11	1	.13	1	.14	1	.13	3	
11, . .	1	.10	1	.12	2	.13	2	.13	4	
12, . .	2	.09	2	.11	3	.13	3	.13	4	
13, . .	3	.09	3	.10	3	.12	4	.12	5	
14, . .	3	.08	3	.10	5	.12	5	.12	8	
15, . .	5	.08	5	.09	5	.12	6	.12	9	
16, . .	6	.07	6	.09	7	.11	7	.13	9	
17, . .	–	–	6	.08	8	.11	8	.13	10	
18, . .	–	–	7	.07	8	.12	9	.14	11	
19, . .	–	–	7	.07	8	.12	10	.15	12	
20, . .	–	–	8	.06	10	.12	11	.17	13	
21, . .	–	–	9	.06	10	.13	11	.18	14	
22, . .	–	–	11	.06	10	.14	14	.21	17	
23, . .	–	–	12	.06	12	.15	14	.23	17	
24, . .	–	–	12	.06	13	.16	15	.27	19	
25, . .	–	–	15	.06	15	.18	18	.30	21	

Computed from tables in Forest Service Bulletin No. 96.

TABLE No. 14. — *Volume Table for Chestnut.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).						
	40	45	50	55	60	65	70
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
5. . . .	15	–	–	–	–	–	–
6. . . .	–	22	27	32	–	–	–
7. . . .	–	30	34	39	50	–	–
8. . . .	–	–	42	50	58	72	–
9. . . .	–	–	56	61	70	81	–
10. . . .	–	–	73	78	85	94	103
11. . . .	–	–	89	93	100	110	122
12. . . .	–	–	–	111	120	132	148
13. . . .	–	–	–	125	138	155	177
14. . . .	–	–	–	–	166	183	208
15. . . .	–	–	–	–	191	211	242
16. . . .	–	–	–	–	220	243	278
17. . . .	–	–	–	–	249	277	318
18. . . .	–	–	–	–	279	315	360

Constructed on the Harvard Forest by Richard T. Fisher and H. B. Shepard in 1915–16. Based on 210 trees cut in an even-aged sprout chestnut stand with 30 to 40 per cent of red oak, black oak, paper birch and other hardwoods; Quality II, age 50 to 60 years, well stocked, trees of normal forest form. Sawing: round-edge lumber, the better quality, amounting to about 80 per cent, 1¼ inches, the balance, including sidings, wormy and knotty or top logs, 1 inch. Minimum size of log: 8 feet long and large enough to yield a board with a 3-inch face.

TABLE NO. 15. — *Volume Table for Red Maple.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).						
	20	30	40	50	60	70	80
	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
3. . . .	0.009	0.011	0.015	0.018	–	–	–
4. . . .	.015	.019	.024	.029	–	–	–
5. . . .	–	.031	.034	.043	0.051	–	–
6. . . .	–	–	.048	.060	.072	0.081	–
7. . . .	–	–	.063	.079	.095	.113	–
8. . . .	–	–	.078	.101	.122	.140	0.153
9. . . .	–	–	.095	.125	.149	.168	.184
10. . . .	–	–	–	.151	.179	.199	.217
11. . . .	–	–	–	.179	.212	.235	.252
12. . . .	–	–	–	.210	.251	.276	.294
13. . . .	–	–	–	.246	.292	.324	.343
14. . . .	–	–	–	.286	.338	.374	.392
15. . . .	–	–	–	.332	.390	.430	.450
16. . . .	–	–	–	.383	.451	.491	.565
17. . . .	–	–	–	–	–	–	.607

Constructed by E. E. Carter and first published in Bulletin of the Harva Forestry Club, Vol. II, 1913, pages 1–8, "A Volume Table for Red Maple on t Harvard Forest." Revised and enlarged by the author in 1915 and published United States Department of Agriculture Bulletin No. 285, "The Northe Hardwood Forest," pages 61–63. The present tables are taken from the lat source. Cubic foot volumes are for stem and branch wood to a minimu diameter, outside the bark, of about 2 inches at the middle of a 4-foot leng The measurements were taken in a wide variety of types, including bottom swale, pine slopes, swamp, and birch and maple coppice. Most of the tr over 6 inches, breast high, were of seedling origin.

In 1920 the cord volume table was given the following test. A square quart acre was laid off in an even-aged mixed hardwood stand. By calipering ea tree and measuring a number of heights the volume in cords was computed the use of the table. The area was then clear cut and the wood piled. T actual volume cut was 5.772 cords; the volume as derived from the table amoun to 5.725 cords. The test indicated that the volume table for red maple is app cable to second growth mixed hardwood, regardless of species.

TABLE NO. 16. — *Volume Table for Red Maple.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).							Basis (Trees).
	20	30	40	50	60	70	80	
	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	
2. . .	0.25	0.35	0.55	–	–	–	–	59
3. . .	.60	.71	1.00	1.2	–	–	–	51
4. . .	1.00	1.30	1.65	2.0	–	–	–	36
5. . .	–	2.15	2.40	3.0	3.6	–	–	38
6. . .	–	–	3.45	4.3	5.2	6.2	–	42
7. . .	–	–	4.70	5.9	7.1	8.4	–	25
8. . .	–	–	6.05	7.8	9.4	10.8	11.8	39
9. . .	–	–	7.65	10.1	12.0	13.5	14.8	28
10. . .	–	–	–	12.7	15.0	16.7	18.2	20
11. . .	–	–	–	15.6	18.5	20.5	22.0	23
12. . .	–	–	–	18.9	22.5	24.8	26.4	10
13. . .	–	–	–	22.6	26.8	29.7	31.4	9
14. . .	–	–	–	26.8	31.6	35.0	36.7	8
15. . .	–	–	–	31.5	37.0	40.7	42.7	3
16. . .	–	–	–	36.6	43.2	47.0	49.7	4
17. . .	–	–	–	–	–	–	58.4	2
								397

TABLE NO. 17. — *Per Cent of Solid Wood in Red Maple Cordwood.*

Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.	Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.	Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.	Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.
3	52.5	7	58.0	11	68.0	15	74.0
4	53.6	8	60.2	12	70.0	16	74.6
5	54 9	9	62.8	13	71.5	17	75.0
6	56.2	10	65.5	14	73.0	–	–

See footnote under Volume Table for Red Maple in Cords.

TABLE NO. 18. — *Number of Red Maple Trees requ yield One Cord of Wood.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).					
	20	30	40	50	60	70
3, . . .	111	91	67	56	–	–
4, . . .	67	53	42	34	–	–
5, . . .	–	32	29	23	20	–
6, . . .	–	–	21	17	14	12
7, . . .	–	–	16	13	11	9
8, . . .	–	–	13	10	8.2	7.1
9, . . .	–	–	11	8.0	6.6	6.0
10, . . .	–	–	–	6.6	5.6	5.0
11, . . .	–	–	–	5.6	4.7	4.3
12, . . .	–	–	–	4.8	4.0	3.6
13, . . .	–	–	–	4.1	3.4	3.1
14, . . .	–	–	–	3.5	3.0	2.7
15, . . .	–	–	–	3.0	2.6	2.3
16, . . .	–	–	–	2.6	2.2	2.0
17, . . .	–	–	–	–	–	–

Derived from Volume Table for Red Maple in Cords.

TABLE No. 19. — *Graded Volume Table for Yellow Birch.*

Used Length, 12 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10. . . .	–	–	–	5	15	10	30
11. . . .	–	–	–	10	15	15	40
12. . . .	–	–	5	15	15	15	50
13. . . .	–	–	5	15	20	20	60
14. . . .	–	–	10	20	20	20	70
15. . . .	–	5	10	25	20	20	80
16. . . .	5	5	15	25	20	20	90
17. . . .	5	5	20	30	20	20	100
18. . . .	10	5	20	30	20	25	110
19. . . .	–	–	–	–	–	–	–
20. . . .	–	–	–	–	–	–	–
21. . . .	–	–	–	–	–	–	–
22. . . .	–	–	–	–	–	–	–
23. . . .	–	–	–	–	–	–	–
24. . . .	–	–	–	–	–	–	–

Used Length, 14 Feet.

10. . . .	–	–	–	5	15	10	30
11. . . .	–	–	–	10	15	15	40
12. . . .	–	–	5	10	15	15	50
13. . . .	–	–	5	15	20	20	60
14. . . .	–	–	10	20	20	20	70
15. . . .	–	5	10	25	20	20	80
16. . . .	5	5	20	30	20	20	100
17. . . .	10	5	20	30	20	25	110
18. . . .	10	5	30	35	25	25	130
19. . . .	15	10	35	35	20	25	140
20. . . .	20	10	45	35	25	25	160
21. . . .	25	15	50	35	20	25	170
22. . . .	35	15	55	35	25	25	190
23. . . .	40	20	65	35	25	25	210
24. . . .	50	20	70	35	25	30	230

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19.—*Graded Volume Table for Yellow Birch*—Continued.

Used Length, 16 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10, . . .	–	–	–	10	15	15	40
11, . . .	–	–	–	15	20	15	50
12, . . .	–	–	5	15	20	20	60
13, . . .	–	–	10	20	20	20	70
14, . . .	–	5	10	25	20	20	80
15, . . .	–	5	15	25	20	25	90
16, . . .	5	5	20	30	20	20	100
17, . . .	10	5	25	30	25	25	120
18, . . .	15	10	30	35	25	25	140
19, . . .	20	10	40	35	20	25	150
20, . . .	25	15	45	35	25	25	170
21, . . .	30	15	55	35	25	30	190
22, . . .	35	15	60	35	25	30	200
23, . . .	40	20	65	40	25	30	220
24, . . .	55	20	80	40	25	30	250

Used Length, 20 Feet.

10, . . .	–	–	–	5	20	25	50
11, . . .	–	–	–	10	25	25	60
12, . . .	–	–	5	15	25	25	70
13, . . .	–	–	5	25	30	30	90
14, . . .	–	–	10	30	30	30	100
15, . . .	–	5	10	30	30	35	110
16, . . .	5	5	20	40	30	40	140
17, . . .	10	5	30	40	30	45	160
18, . . .	15	10	35	45	30	45	180
19, . . .	20	10	45	50	30	45	200
20, . . .	30	15	50	50	30	45	220
21, . . .	35	15	60	55	35	50	250
22, . . .	40	20	70	55	35	50	270
23, . . .	50	25	75	60	35	55	300
24, . . .	65	30	85	60	35	55	330

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19. — *Graded Volume Table for Yellow Birch* — Continued.

Used Length, 22 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10.	–	–	–	5	20	25	50
11.	–	–	5	15	25	25	70
12.	–	–	5	20	25	30	80
13.	–	–	5	25	30	30	90
14.	–	–	10	30	30	30	100
15.	–	5	15	35	30	35	120
16.	5	10	25	40	30	40	150
17.	10	10	30	45	30	45	170
18.	15	10	40	50	30	45	190
19.	22	10	45	50	35	50	210
20.	30	15	55	55	35	50	240
21.	35	15	65	60	35	50	260
22.	45	20	70	60	35	50	280
23.	50	25	80	60	40	55	310
24.	65	30	90	60	40	55	340

Used Length, 24 Feet.

10.	–	–	–	10	25	25	60
11.	–	–	–	15	25	30	70
12.	–	–	–	20	30	30	80
13.	–	–	10	30	30	30	100
14.	–	–	10	35	30	35	110
15.	5	5	15	35	30	40	130
16.	10	10	25	40	35	40	160
17.	10	10	30	50	35	45	180
18.	15	10	40	50	35	50	200
19.	20	10	50	55	35	50	220
20.	30	15	60	60	35	50	250
21.	35	20	65	60	40	50	270
22.	40	20	75	65	40	50	290
23.	50	25	85	65	40	55	320
24.	70	30	95	65	40	60	360

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19.—*Graded Volume Table for Yellow Birch*—Continued.

Used Length, 26 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
12, . . .	–	–	10	20	30	30	90
13, . . .	–	–	10	30	30	30	100
14, . . .	–	–	10	35	30	35	110
15, . . .	–	–	15	40	35	40	130
16, . . .	5	5	25	45	35	45	160
17, . . .	10	10	35	50	35	50	190
18, . . .	15	10	45	55	35	50	210
19, . . .	25	10	55	60	40	50	240
20, . . .	30	15	60	60	40	55	260
21, . . .	35	15	70	65	40	55	280
22, . . .	45	20	75	70	40	60	310
23, . . .	50	25	85	70	40	60	330
24, . . .	65	30	100	70	45	60	370

Used Length, 28 Feet.

12, . . .	–	–	5	20	35	30	90
13, . . .	–	–	10	30	35	35	110
14, . . .	–	5	10	35	35	35	120
15, . . .	–	5	20	40	35	40	140
16, . . .	10	5	30	45	35	45	170
17, . . .	10	10	40	50	40	50	200
18, . . .	15	10	50	55	40	50	220
19, . . .	25	15	55	60	40	55	250
20, . . .	30	15	65	65	40	55	270
21, . . .	35	20	70	65	40	60	290
22, . . .	45	20	80	70	45	60	320
23, . . .	55	30	90	70	45	60	350
24, . . .	70	35	105	70	45	65	390

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19. — *Graded Volume Table for Yellow Birch* — Continued.

Used Length, 30 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
12. . . .	–	–	–	–	–	–	–
13. . . .	–	–	–	–	–	–	–
14. . . .	–	–	–	–	–	–	–
15. . . .	–	5	20	40	40	45	150
16. . . .	10	5	30	45	40	50	180
17. . . .	10	10	40	55	40	55	210
18. . . .	15	10	50	60	40	55	230
19. . . .	25	15	55	65	40	60	260
20. . . .	30	15	65	65	45	60	280
21. . . .	40	20	75	70	45	60	310
22. . . .	45	25	80	70	45	65	330
23. . . .	55	30	90	75	45	65	360
24. . . .	70	35	110	75	45	65	400

Used Length, 32 Feet.

15. . . .	5	5	20	45	40	45	160
16. . . .	10	10	30	50	40	50	190
17. . . .	15	10	40	60	40	55	220
18. . . .	15	10	50	60	45	60	240
19. . . .	25	15	60	65	45	60	270
20. . . .	30	15	70	70	45	60	290
21. . . .	40	20	75	75	45	65	320
22. . . .	45	20	85	75	50	65	340
23. . . .	55	25	95	75	50	70	370
24. . . .	75	35	115	75	50	70	420

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19.—*Graded Volume Table for Yellow Birch*—Concluded.

Used Length, 34 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
15, . . .	–	–	–	–	–	–	–
16, . . .	10	10	35	50	45	50	200
17, . . .	15	10	40	60	45	60	230
18, . . .	15	10	55	60	45	65	250
19, . . .	25	15	60	70	45	65	280
20, . . .	30	15	70	70	50	65	300
21, . . .	40	20	80	75	50	65	330
22, . . .	45	25	90	80	50	70	360
23, . . .	55	30	95	80	50	70	380
24, . . .	75	35	115	80	50	75	430

Used Length, 36 Feet.

15, . . .	–	–	–	–	–	–	–
16, . . .	10	10	35	50	45	50	200
17, . . .	15	10	45	60	45	65	240
18, . . .	20	10	55	65	45	65	260
19, . . .	25	15	60	70	50	70	290
20, . . .	30	15	70	75	50	70	310
21, . . .	40	20	80	80	50	70	340
22, . . .	45	25	90	80	55	75	370
23, . . .	50	30	100	80	55	75	390
24, . . .	75	35	120	85	55	80	450

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE NO. 20. — *Graded Volume Table for Sugar Maple.*

Used Length, 12 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10.	–	–	10	20	30
11.	–	–	10	20	30
12.	–	10	10	20	40
13.	5	10	10	25	50
14.	10	15	10	25	60
15.	10	20	15	25	70
16.	15	30	15	30	90
17.	20	35	15	30	100
18.	30	35	15	30	110

Used Length, 16 Feet.

10.	–	5	10	25	40
11.	–	10	10	20	40
12.	5	10	10	25	50
13.	5	15	15	25	60
14.	10	20	15	25	70
15.	10	30	20	30	90
16.	15	35	20	30	100
17.	20	40	20	30	110
18.	30	40	20	40	130

Used Length, 20 Feet.

10.	–	5	15	30	50
11.	–	10	15	35	60
12.	5	15	15	35	70
13.	5	15	20	40	80
14.	10	25	20	45	100
15.	15	35	20	50	120
16.	20	45	25	50	140
17.	30	50	25	55	160
18.	40	55	25	60	180

For notes on construction and use see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 20. — *Graded Volume Table for Sugar Maple* — Continued.

Used Length, 24 Feet.

Diameter, Breast High (Inches).	Grade of Lumber.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10,	–	5	15	40	60
11,	–	10	20	40	70
12,	5	15	20	40	80
13,	5	20	20	45	90
14,	10	30	20	50	110
15,	15	40	25	50	130
16,	20	45	30	55	150
17,	30	50	30	60	170
18,	40	60	30	60	190

Used Length, 28 Feet.

11,	–	15	20	45	80
12,	5	20	20	45	90
13,	5	25	20	50	100
14,	10	35	25	50	120
15,	15	40	30	55	140
16,	25	50	30	55	160
17,	35	55	30	60	180
18,	45	65	30	60	200

Used Length, 32 Feet.

11,	–	15	25	50	90
12,	5	20	25	50	100
13,	5	25	25	55	110
14,	10	35	30	55	130
15,	15	45	30	60	150
16,	25	50	30	65	170
17,	35	60	30	65	190
18,	45	70	35	70	220

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 20. — *Graded Volume Table for Sugar Maple* — Concluded.

Used Length, 36 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
12, ...	5	20	25	60	110
13, ...	5	30	30	65	130
14, ...	10	40	30	70	150
15, ...	15	50	35	70	170
16, ...	25	55	35	75	190
17, ...	35	65	35	75	210
18, ...	50	70	40	80	240

Used Length, 40 Feet.

13, ...	5	30	35	70	140
14, ...	10	40	35	75	160
15, ...	15	50	35	80	180
16, ...	25	55	40	80	200
17, ...	35	65	45	85	230
18, ...	45	75	45	95	260

For notes on construction and use, see footnote under Grade1 Mill Tally Log Rule, page 15.

TABLE NO. 21. — *Graded Volume Table for Beech.*

Used Length, 12 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10,	–	5	10	25	40
11,	–	5	10	25	40
12,	–	10	10	30	50
13,	–	15	15	30	60
14,	5	20	15	30	70
15,	10	20	15	35	80
16,	15	25	15	35	90
17,	20	25	15	40	100
18,	20	30	20	40	110

Used Length, 16 Feet.

10,	–	10	10	30	50
11,	–	10	15	35	60
12,	5	15	15	35	70
13,	5	20	15	40	80
14,	10	20	20	40	90
15,	10	25	20	45	100
16,	15	30	20	45	110
17,	20	35	25	50	130
18,	25	40	25	50	140

Used Length, 20 Feet.

11,	–	10	15	45	70
12,	–	15	20	45	80
13,	–	20	20	50	90
14,	10	25	25	50	110
15,	10	30	25	55	120
16,	15	40	25	60	140
17,	20	45	25	60	150
18,	25	50	30	65	170

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 21. — *Graded Volume Table for Beech* — Concluded.

Used Length, 24 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
11.	–	10	20	50	80
12.	–	20	20	50	90
13.	5	25	25	55	110
14.	10	30	30	60	130
15.	10	35	30	65	140
16.	20	40	30	70	160
17.	25	45	35	75	180
18.	30	55	35	80	200

Used Length, 28 Feet.

11.	–	15	25	60	100
12.	–	20	25	65	110
13.	5	25	25	65	120
14.	10	30	30	70	140
15.	15	35	35	75	160
16.	20	45	35	80	180
17.	30	50	40	80	200
18.	40	60	40	90	230

Used Length, 32 Feet.

12.	5	25	25	65	120
13.	5	25	30	70	130
14.	10	35	30	75	150
15.	20	40	35	85	180
16.	25	45	40	90	200
17.	30	50	45	95	220
18.	45	60	45	100	250

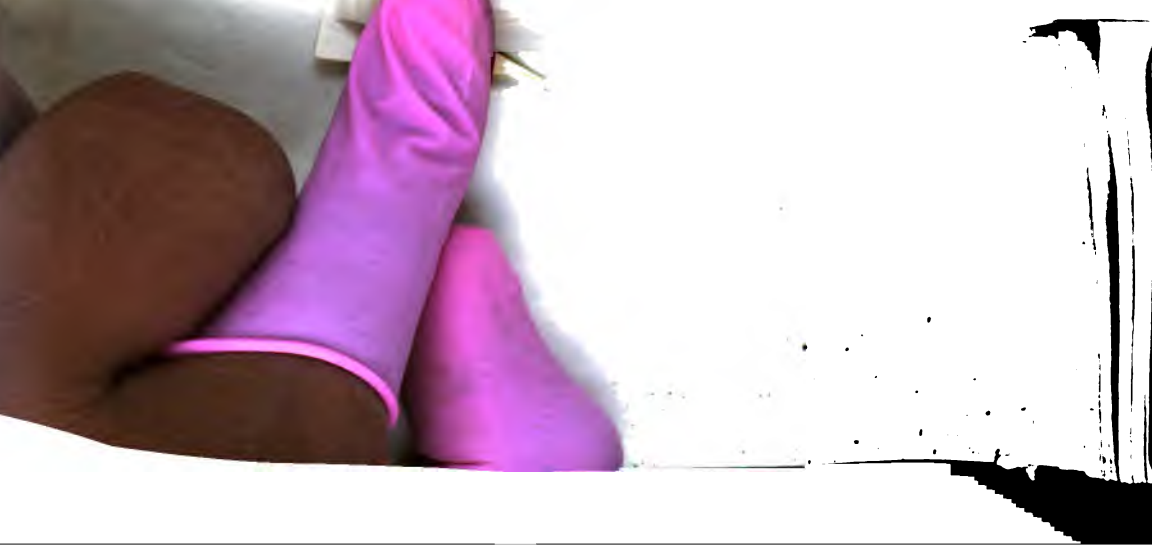
For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

YIELD TABLES.

Yield tables show the volume in board feet or other units for an acre of fully-stocked woodland at any given age. By the term "fully-stocked" we mean that the crowns of the trees occupy all the available space on the acre and that there are no blanks nor openings.

A yield table can be used to predict the future yield of young or middle-age stands. The owner finds the age and volume of his present stand in order to determine in which quality site it belongs, and from the table he can predict its yield at any period in the future. In making his calculations allowance must be made for the fact that his immature stand may not be fully stocked. In the same way the yield table is necessary in predicting the returns from an investment in planting. They are of particular value in suits where damage to immature timber is involved, for in such case the loss is the destruction of possible future growth. They are of some use in estimating the present contents of stands if the estimator can determine the present age, and, from the height the quality of the site on which his stand is growing.

For the data on the pine yield tables 177 sample plots were measured in stands ranging from twenty to seventy years. All the trees on each quarter or eighth acre plot were calipered and the volumes computed from the volume tables. These sample plots were divided into three site or soil classes (called Quality I, II, III) according to their rate of growth in volume. It has since been generally agreed by foresters that height growth is a better index of quality of site than volume, and the yield tables on hardwoods are divided on this basis. For the latter, two sets of tables are given, one of which includes all trees of 2 inches diameter and over, in which the mer



chantable volume is expressed entirely as cordwood; and second, a table containing only the trees of over 7 inches diameter, where the merchantable volume is expressed in board feet and additional cordwood. There is a third yield table for inferior hardwoods. By the term "inferior hardwoods" is meant stands composed principally of gray birch, red maple and poplar. Naturally the amount of saw timber to be obtained from such weed species is small.

TABLE No. 22. — *Normal Yield per Acre, in Cubi and Cords, of Better Second Growth Hardwood in Central New England.*

SITE CLASS I.

All trees 2 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Basal Area (Square Feet).	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).
20, . . .	1,250	66.0	27.1	3.11	1,041	15.80
25, . . .	1,120	90.8	33.0	3.86	1,625	23.71
30, . . .	1,010	107.2	37.5	4.41	2,150	29.75
35, . . .	900	119.9	41.5	4.94	2,628	34.96
40, . . .	800	130.2	45.0	5.46	3,058	39.63
45, . . .	700	139.7	48.2	6.05	3,495	44.03
50, . . .	610	148.0	50.7	6.69	3,898	48.00
55, . . .	525	155.7	53.1	7.37	4,298	51.84
60, . . .	450	162.5	55.4	8.14	4,677	55.50
65, . . .	390	169.0	57.8	8.91	5,068	59.25
70, . . .	340	175.1	59.8	9.72	5,462	62.75
75, . . .	300	180.9	61.9	10.51	5,833	66.18
80, . . .	270	186.3	64.0	11.25	6,200	69.50

First published in Harvest Forest Bulletin No. 2, "Growth Study Yield Tables for Second Growth Hardwood Stands in Central Nev J. Nelson Spaeth. Data gathered in northern Worcester County, M Based on forty fully stocked, natural, even-aged sample plots con 15,000 trees. The principal species were red oak, white ash, red map wood. Cubic foot and cord volumes were obtained by the use of Ha Revised Red Maple Volume Tables (tables 15 and 16 in this Handb foot volumes were computed by the use of Clark's International I published in Graves's "Mensuration"), which agrees closely with a from the customary round-edge sawing. Conclusions drawn fron were that, for even-aged second growth hardwood stands, in spite o tion in percentage of species in mixture, for a given site, age and volume in board feet, cubic feet and cords is constant; also that tl a tree of given height and diameter in cords and cubic feet is the san of species. (For full discussion see original publication.)

TABLE No. 23. — *Normal Yield per Acre, in Cubic Feet and Cords, of Better Second Growth Hardwood Stands in Central New England.*

SITE CLASS II.

All trees 2 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Basal Area (Square Feet).	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	Forest Form Factor.
25, . . .	1,360	59.8	27.8	2.84	982	14.65	.593
30, . . .	1,235	77.9	31.8	3.40	1,380	20.40	.557
35, . . .	1,125	91.1	34.8	3.86	1,798	25.48	.567
40, . . .	1,030	101.6	37.4	4.25	2,180	29.53	.574
45, . . .	940	110.3	39.8	4.66	2,534	33.04	.577
50, . . .	855	117.9	41.5	4.94	2,828	35.98	.580
55, . . .	775	124.6	42.8	5.43	3,118	38.55	.584
60, . . .	700	130.7	44.2	5.85	3,375	41.08	.584
65, . . .	630	136.6	45.3	6.31	3,638	43.42	.587
70, . .	565	142.2	46.3	6.79	3,895	45.61	.592
75, . . .	500	147.7	47.0	7.36	4,146	47.75	.598
80, . . .	440	153.0	47.6	7.98	4,390	49.80	.601

See footnote to Table No. 22, page 50.

TABLE NO. 24. — *Normal Yield per Acre in Board F*
Additional Cords, Cubic Feet and Cords of Better
Growth Hardwood Stands in Central New Englan

SITE CLASS I.
All trees 7 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	VOLU A
						Board Feet.
30, . . .	37	51.9	7.28	350	5.2	1,46
35, . . .	147	57.0	7.86	1,280	13.8	2,90
40, . . .	186	61.3	8.45	1,950	21.3	4,72
45, . . .	205	64.8	9.00	2,549	28.3	7,13
50, . . .	216	68.1	9.48	3,120	34.8	10,31
55, . . .	223	71.0	9.97	3,680	40.6	13,16
60, . . .	226	73.6	10.53	4,240	46.1	15,62
65, . . .	227	75.9	11.08	4,810	51.2	17,85
70, . . .	226	78.0	11.59	5,360	56.0	19,83
75, . . .	224	79.8	12.10	5,900	60.8	21,70
80, . . .	220	81.5	12.62	6,450	65.6	23,40

See footnote to Table No. 22, page 50.

TABLE No. 25. — *Normal Yield per Acre in Board Feet and Additional Cords, Cubic Feet and Cords of Better Second Growth Hardwood Stands in Central New England.*

SITE CLASS II.

All trees 7 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	VOLUME PER ACRE.	
						Board Feet.	Additional Cords.
35. . . .	56	49.4	7.25	530	6.7	800	4.7
40. . . .	104	54.5	7.85	1,010	14.0	1,920	9.1
45. . . .	133	56.7	8.41	1,460	19.7	3,250	11.4
50. . . .	157	59.4	8.78	1,870	24.6	4,780	12.3
55. . . .	175	61.6	9.15	2,250	29.1	6,600	12.2
60. . . .	188	63.2	9.51	2,620	32.8	8,660	10.2
65. . . .	197	64.4	9.90	2,970	36.4	10,850	8.6
70. . . .	203	65.4	10.32	3,310	39.7	12,710	7.1
75. . . .	206	66.2	10.75	3,660	42.7	14,220	6.2
80. . . .	207	66.8	11.21	4,020	46.0	15,380	6.1

See footnote to Table No. 22, page 50.

TABLE NO. 26. — *Normal Yield in Cubic Feet and* (
Inferior Second Growth Hardwood Stands in Cent
England.

All trees 2 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).
17, ...	1,050	28.6	2.71	670
18, ...	1,535	29.3	2.80	830
19, ...	1,610	29.9	2.87	990
20, ...	1,708	30.5	2.92	1,130
21, ...	1,750	31.1	2.95	1,230
22, ...	1,774	31.6	2.98	1,300
23, ...	1,778	32.1	3.01	1,360
24, ...	1,768	32.5	3.03	1,400
25, ...	1,743	32.9	3.05	1,430
26, ...	1,710	33.3	3.07	1,440
27, ...	1,671	33.6	3.10	1,450
28, ...	1,623	33.9	3.13	1,455
29, ...	1,575	34.1	3.17	1,460
30, ...	1,515	34.4	3.21	1,460

See footnote to Table No. 22, page 50.

TABLE NO. 27. — *Yield Table for White Pine.*

AGE (YEARS).	QUALITY I.			QUALITY II.			QUALITY III.		
	1-Inch Boards.	Caliper Cords.	Cubic Feet.	1-Inch Boards.	Caliper Cords.	Cubic Feet.	1-Inch Boards.	Caliper Cords.	Cubic Feet.
25.	10,825	25.1	2,080	6,750	16.4	1,300	3,975	10.8	750
30.	19,900	44.0	3,750	12,500	31.2	2,740	7,500	18.2	1,400
35.	31,150	60.4	5,420	24,400	49.0	4,375	16,950	35.8	3,035
40.	40,650	70.6	6,590	32,800	58.0	5,300	25,200	46.2	4,080
45.	49,350	78.0	7,420	40,600	64.8	6,075	32,100	51.8	4,785
50.	55,150	84.2	8,035	46,500	70.0	6,725	37,550	56.6	5,475
55.	59,650	89.2	8,575	50,550	74.8	7,200	42,100	60.8	6,015
60.	63,600	93.4	9,075	53,200	79.2	7,655	44,550	64.6	6,340
65.	67,050	97.2	9,550	56,600	83.0	8,050	46,150	68.4	6,550

Constructed by State Forester. Data obtained by measuring 177 sample plots in all parts of Massachusetts.

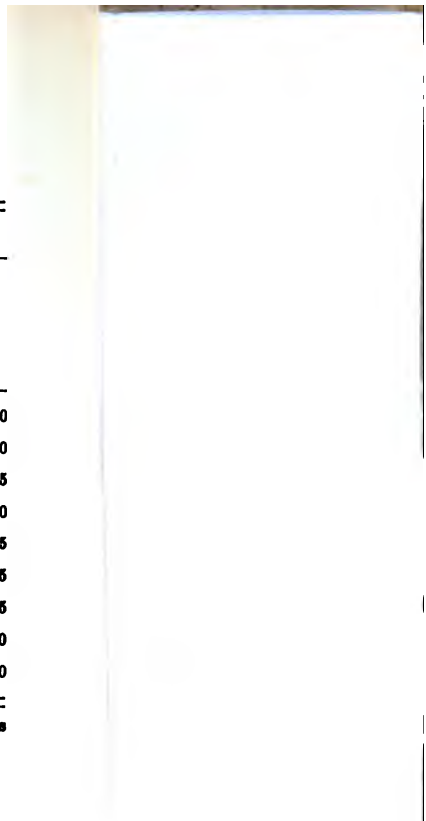


TABLE No. 28. — *Yield from Thinnings.*

Trees under 5 inches, from report of the New Hampshire Forestry C
1906.

AGE (YEARS).	TREES OVER 5 INCHES IN DIAMETER.		TREES UN INCHES IN D
	Board Feet.	Cubic Feet.	Cords.
25, ...	1,400	280	7½
30, ...	3,700	720	6
35, ...	4,950	850	4½
40, ...	6,000	1,030	3
45, ...	6,800	1,140	1½
50, ...	7,400	1,240	-
55, ...	7,900	1,310	-

GROWTH.

The two following tables represent the average g
white pine in volume and height as found in diffe
tions or sites. Volume growth is expressed in s
feet, because it is the best unit for scientific mea
The material for growth study is obtained from a
measurements called a "stem analysis." The trees
and sawed into sections which are subject to the
measurements. The diameter on the stump and
are taken, also the diameters at the large and sm
each log and its length, and the diameter at the b
top and its length. All these diameters are taken
bark. The stump is cubed as a cylinder, each l

frustum of a paraboloid, and the top as a cone. By counting back on the annual rings, and measuring the diameter at every tenth ring, we can obtain the cubical contents of the tree as it was ten years, twenty years, ago, and so on back until it was in the neighborhood of ten years old. The trees growing in what is described as rich lowland show the most rapid growth in volume, although those described as coming from upland pasture are not far behind. It is quite probable that the latter trees were growing under somewhat more crowded conditions, and did not have quite as much opportunity to develop their diameter growth to its fullest capacity. That they were more crowded is indicated by the fact that the tables on height growth show a slightly higher rate for the upland pasture trees. The rate of growth for trees on sandy soil is very much slower than that for the other two types, being not much over 50 per cent the rate of the lowland type. This seems to refute the prevailing idea that soil and moisture conditions have very little effect on the growth of pines. In this connection it is interesting to note that the rate of growth of pines in wet swamp is the lowest of all, indicating that too much water retards the growth of pines even more than too little.

The tables of height growth follow the same general lines as those for volume growth, except that, as stated above, upland pasture slightly exceeds that of rich lowland. The rate for the favorable sites (upland pasture and lowland) exceeds that of the less favorable sites by 20 or 25 per cent, a difference in rate somewhat less than that of the volume growth.

TABLE No. 29. — *Growth Tables. — Growth in Vol*

AGE (YEARS).	Rich Lowland. 109 Trees.	Upland Pasture. 73 Trees.	Sandy Soil. 16 Trees.
	Cu. Ft.	Cu. Ft.	Cu. Ft.
10, ...	.8	.6	.4
15, ...	1.8	1.2	.5
20, ...	3.0	2.0	1.4
25, ...	5.5	4.5	2.5
30, ...	9.0	7.5	4.0
35, ...	13.5	11.5	6.3
40, ...	19.5	16.6	9.3
45, ...	26.5	22.0	12.5
50, ...	35.0	27.7	16.0
55, ...	43.5	34.5	19.8
60, ...	51.5	41.7	23.6
65, ...	60.0	49.0	27.5
70, ...	68.0	56.0	31.2
75, ...	75.5	–	35.3
80, ...	84.0	–	39.0
85, ...	93.5	–	42.8
90, ...	–	–	–
95, ...	–	–	–

TABLE NO. 30. — *Growth Tables. — Growth in Height.*

AGE (YEARS).	Upland Pasture. 73 Trees.	Rich Lowland. 109 Trees.	Sandy Soil. 16 Trees.	Wet Swamp. 47 Trees.
	Feet.	Feet.	Feet.	Feet.
10,	9	8	5	4
15,	16	15	14	10
20,	24	23	23	16
25,	32	31	30	22
30,	40	39	36	28
35,	47	46	40	34
40,	53	52	44	39.
45,	59	57	48	43
50,	64	62	51	48
55,	69	66	54	51
60,	73	69	57	54
65,	76	71	59	57
70,	80	73	61	60
75,	82	75	63	62
80,	84	77	65	65
85,	87	79	–	68
90,	89	80	–	70
95,	90	–	–	–
100,	91	–	–	–

TABLE NO. 31. — *White Spruce Growth Table for Ea*
Stands.

AGE.	Diameter, Breast-high (Inches).	Total Height (Feet).	Merchantable Height (Feet).	Total Volume (Cubic Feet).	Merchantable Volume (Cubic Feet).	Mean Annual Growth (Cubic Feet).
10, . . .	1.2	7.1	–	0.2	–	0.020
15, . . .	2.6	12.8	–	0.7	–	0.046
20, . . .	4.3	20.2	–	1.5	–	0.075
25, . . .	5.6	27.6	12	2.7	2.0	0.108
30, . . .	6.6	34.5	17	4.2	3.9	0.130
35, . . .	7.3	40.2	23	6.2	5.8	0.166
40, . . .	7.8	45.2	28	8.3	7.7	0.192
45, . . .	8.4	49.6	34	10.4	9.7	0.215
50, . . .	8.9	53.4	38	12.5	11.6	0.232
55, . . .	9.3	56.8	42	14.6	13.5	0.245
60, . . .	9.8	59.7	45	16.7	15.5	0.25[illegible]
65, . . .	10.3	62.2	48	18.8	17.4	0.26[illegible]
70, . . .	10.9	64.3	52	20.8	19.3	0.27[illegible]

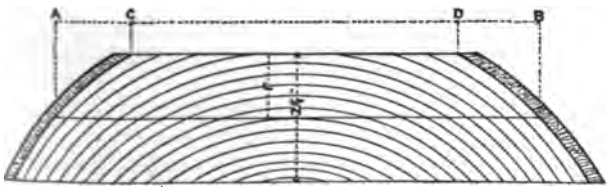
Based on measurement of 199 trees (curved), by H. B. Shepa
Lincoln Pulp Company, 1920. Periodic annual growth (cubic feet a
is for ten-year periods, *i.e.*, 10 to 20, 15 to 25, etc., based on total v

MISCELLANEOUS NOTES.

While gathering the data for the pine tables in this bulletin it was possible to investigate several related problems which are of especial interest to lumber operators. The available data may not be sufficient in every case to yield conclusive results, but they are offered for what they are worth.

Sawing Boards and Planks.

As has been stated before, nearly all our native pine logs are sawed in round-edge lumber in two general classes, the first being box boards which are usually 1 or 1¼ inches in thickness, and the second plank or butt cuts, which are 2½ inches in thickness. The log scale on page 12, compiled by the Massachusetts Forestry Department, was derived from logs sawed into box boards, while the scale compiled at the Harvard Forest was derived from logs sawed largely into plank. If the two scales are compared, one will note that with the smaller logs box boards show a higher yield than plank, while in the larger logs the positions are reversed. The following diagram of a 2½-inch plank taken



Comparison of Scale in Sawing 2½" Plank and 1" Boards

from a small log will serve to explain the reason. The plank is scaled on the narrow face C–D and the result multiplied

by 2, whereas if that plank were sawed into two 1-inch boards we would have the combined scales C–D plus A–B, which is larger than twice C–D by A–C and D–B. The larger the logs, however, the smaller the wane, that is, the smaller the difference between the wide and narrow face, so that with the wider planks there is no loss in scale and there is an actual saving in lumber due to the fewer saw kerfs made in sawing 2-inch instead of 1-inch lumber. Therefore on the large logs the rule for plank exceeds that for box boards.

Band Saw versus Circular.

A portable mill located near Manchaug was equipped with a band saw instead of a circular, so that it was possible by constructing a mill tally rule at this mill to compare the result of using a band saw which makes a kerf only one-eighth of a inch in width with a mill tally rule represented by the general Massachusetts rule, which allow for a circular saw kerf of one quarter of an inch. The two rules are printed in parallel columns below, and a comparison will show an average gain of 2 per cent in the yield of pine logs by using the band saw. It would seem that this saving would justify a more thorough tryout of the band saw, even in connection with a portable mill.

TABLE NO. 32. — *Comparison of Log Scales (Band Saw versus Circular Saw).*

DIAMETER AT SMALL END (INCHES).	10-FOOT LOGS.		12-FOOT LOGS.		14-FOOT LOGS.	
	Band Saw.	Circular Saw.	Band Saw.	Circular Saw.	Band Saw.	Circular Saw.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
4. . . .	12	9	15	13	20	17
5. . . .	17	13	21	17	26	21
6. . . .	23	17	27	22	34	27
7. . . .	30	23	35	29	43	35
8. . . .	38	30	45	37	54	44
9. . . .	49	39	57	47	67	55
10. . . .	61	48	71	58	81	68
11. . . .	75	58	86	70	98	82
12. . . .	90	69	102	83	116	97
13. . . .	107	80	121	96	136	113
14. . . .	124	104	142	111	158	131
15. . . .	–	117	166	129	180	150
16. . . .	–	131	–	146	204	170

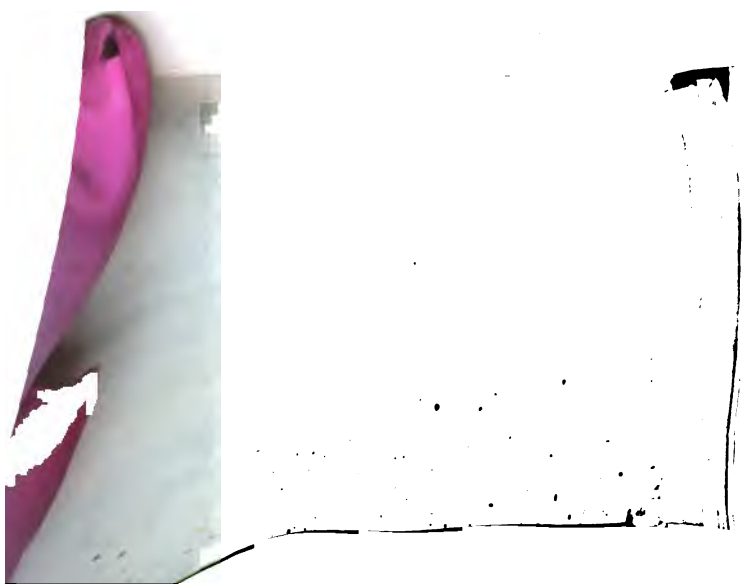
Round-edge versus Square-edge Lumber.

Lumber operators generally recognize the fact that logs sawed into square-edge boards do not yield as much lumber as those sawed into round-edge lumber, but they are not often aware of the precise difference, or why it comes about. We obtained from Mr. Austin Cary a mill tally scale made at a portable mill in Maine which was producing square-edge lumber only, and we have printed that in parallel columns with our Massachusetts rule representing the round-edge yield.

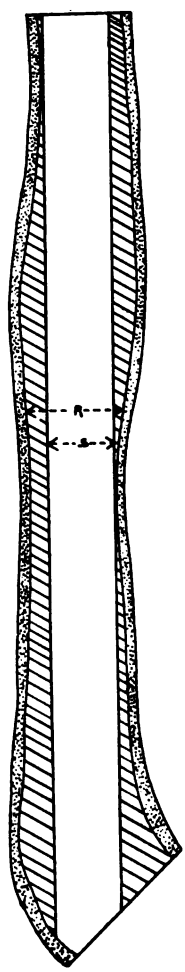
The reader will note that the difference in favor of the
edge sawing is from 10 to 15 per cent in the smaller lo
gradually diminishes until it reaches zero in the case
16-inch logs. This is as it should be in theory, becau
difference between the two methods of sawing is due
slab which must be removed to produce square-edge l
and the proportion of slab to the yield in lumber becom
and less as the log increases in size. One will also no
the 14-foot log shows a larger difference than the 12-fo
This is due to the fact that there is a greater taper an
sequently greater proportionate waste in slab in squari
longer logs.

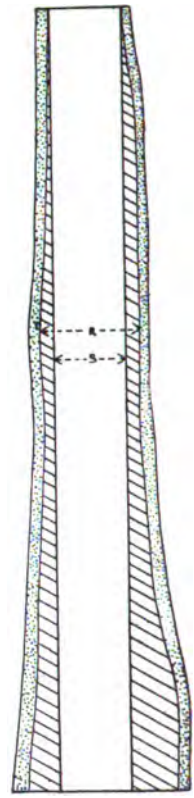
TABLE No. 33. — *Comparison of sawing Round and Squa*
Lumber.

DIAMETER AT SMALL END (INCHES).	12-FOOT LOGS.			14-FOOT LOGS.	
	Cary (Square Edge).	Massachusetts (Round Edge).	Per Cent Difference.	Cary (Square Edge).	Massachusetts (Round Edge).
	Ft. B. M.	Ft. B. M.		Ft. B. M.	Ft. B. M.
6, . . .	20	22	10.00	23	27
7, . . .	26	29	11.53	30	35
8, . . .	33	37	12.12	39	44
9, . . .	43	47	9.34	50	55
10, . . .	54	58	9.25	61	68
11, . . .	67	70	4.46	75	82
12, . . .	81	83	2.46	90	97
13, . . .	95	96	1.05	105	113
14, . . .	110	111	.90	124	131
15, . . .	128	129	.78	135	150
16, . . .	146	146	–	160	.170



The following diagrams explain more clearly the loss of scale and lumber that comes in squaring round-edge lumber. As has been said before, round-edge lumber is scaled on the narrow face at the point of average width; on the other hand, if the board is squared its width is limited by the dimension at the small end or at some other narrow point. The two diagrams show the effect of squaring two round-edge boards, one with an excessive amount of taper and the other with a bad crook. The dotted line R represents the scale of the round-edge board, and the line S the scale of the square-edge board. Although there is a considerable loss in scale, there is even a larger loss in material.


R
S


R
S

Equivalent Factors.

The following table contains a series of converting factors which are often useful. The first shows the number of board feet that one can expect to obtain from a log per cubic foot of solid wood. If one has a log which he wishes to scale and is not equipped with a log rule, he can find the solid contents by cubing the log as the frustum of a cone, and then, remembering that the average log will yield 7 board feet per cubic foot, he can convert his cubic contents into board feet. These are the factors for round-edge lumber. In the case of square-edge lumber an average factor is about 6.5 board feet.

One will note that the equivalent factor is only 5 feet for small logs, and 7.5 for the larger. The increase is due to the fact that in the sawing of smaller logs there is a larger percentage of wood which must be wasted in the form of slab and saw kerf.

In the chapter on log rules we called attention to the caliper cord. In commercial practice it is usual to state that it takes a cord and a half to equal a thousand feet, or, to reverse the statement, a cord is equal to 670 board feet of inch lumber. Reference to the table will show that this is a very satisfactory converting factor for a run of logs. The increase in yield from the smaller to the larger logs is due to the same reason as that advanced for the yield per cubic foot, namely, the higher percentage of waste in smaller logs. In southeastern Massachusetts, where the practice is to saw $\frac{5}{8}$-inch lumber, it is common to call 1,000 feet of this sort of lumber equivalent to a cord, although an average run of logs will slightly exceed this yield.

TABLE NO. 34. — *Table showing Equivalent Factors fc changing Cubic Feet to Board Feet and Cords to Boar Feet — White Pine.*

DIAMETER AT MIDDLE OF LOG (INCHES).	Number of Board Feet per Cubic Foot of Solid Wood.	Number of Board Feet per Cord.
5,	5.0	488
6,	5.6	560
7,	6.0	590
8,	6.4	636
9,	6.5	645
10,	6.6	646
11,	6.7	648
12,	6.8	654
13,	6.8	684
14,	6.9	707
15,	7.0	714
16,	7.1	714
17,	7.2	721
18,	7.3	726
19,	7.4	733
20,	7.4	738
21,	7.4	744
22,	7.5	752
23,	7.5	742
24,	7.5	730

MEASUREMENT OF FUEL.

There is considerable confusion attendant upon the buying and selling of fuel wood because it is sold as one thing while the purchaser receives it in another form. It is sold as cord-wood; *i.e.*, wood in sticks 4 feet long piled so as to occupy 128 cubic feet of space, but it is delivered to the consumer as fuel wood cut into lengths 2 feet or less. The State Forester made an investigation to determine the amount of space that an average cord of wood should occupy after it has been cut into the ordinary commercial lengths, — 24-inch, 16-inch, 12-inch, — and then thrown loose into a bin or restacked. At the same time, we experimented to obtain the number of 2 and 4 bushel baskets per cord. We used approximately 150 cords of hardwood of different types, — all cleft, all round, mixed round and cleft, — and the table below gives the average results of those experiments. An attempt was made to make these figures legal standard for a cord, but the proposition was rejected by the Legislature.

TABLE No. 35. — *Fuel Wood Units per Cord.*

12-Inch Lengths.

Thrown Cubic Feet per Cord).	Basis (Cords).	Stacked (Cubic Feet per Cord).	Basis (Cords).	2-Bushel Baskets (per Cord).	Basis (Cords).	4-Bushel Baskets (per Cord).	Basis (Cords).
145	45	101	21	54½	11	25½	8
16-Inch Lengths.							
161	25	106	12	59	9	26	7
24-Inch Lengths.							
183	11	110	11	-	-	34	9

Constructed from data collected by State Forester.

BULLETIN 115

Seventeenth Annual Report

OF THE

Massachusetts Forestry Association

FOUNDER
JOSEPH S. NOWELL

1914

OFFICERS—1915

Presidents of the Associati

HENRY P. WALCOTT, 1898-19
NATHANIEL T. KIDDER, 191

Vice-Presidents

Berkshire—HELOISE MEYER, Lenox.
Bristol—WM. E. FULLER, JR., Fall R
Essex—BENJAMIN S. JOHNSON, Lyn
Franklin—W. B. GAINES, Greenfield
Hampden—SAMUEL BOWLES, Springf
Hampshire—KENYON L. BUTTERFIEL
Middlesex—MRS. FRED H. TUCKER,
Norfolk—S. M. WELD, Dedham.
Plymouth—G. R. BRIGGS, Plymouth.
Suffolk—EDWIN D. MEAD, Boston.
Worcester—JOHN E. THAYER, Lanc

Secretary

HARRIS A. REYNOLDS, Cambri

Treasurer

ERNEST B. DANE, Brooklin

Auditors

JAMES NOWELL, Wincheste
H. WADSWORTH HIGHT, Winch

Trustees of the Permanent F

JOHN NOBLE, Boston. GEORGE M. W
GEORGE N. WHIPPLE, Bosto

COMMITTEES FOR 1915

Executive

NATHANIEL T. KIDDER, Chairman.

JOHN S. AMES, '16,
FREDERICK J. CAULKINS, '15
FRANK A. CUTTING, '17,
ERNEST B. DANE,
HARRY F. GOULD, '16,
HARRIS A. REYNOLDS,
MARY LEE WARE, '15,
WILLIAM P. WHARTON, '17.

Membership

Vice-Presidents and Ways and Means Committee.

Legislation

ALLEN CHAMBERLAIN, Chairman.

LOUIS L. GREEN,
JOHN NOBLE,
D. BLAKELY HOAR,
HARRIS A. REYNOLDS.

Forest

FREDERICK J. CAULKINS, Chairman,
FRANK A. CUTTING,
HARRY F. GOULD

Tree

WILLIAM P. WHARTON, Chairman,
NATHANIEL T. KIDDER,
JOHN S. AMES.

Ways and Means

NATHANIAL T. KIDDER, Chairman,
ERNEST B. DANE,
MARY LEE WARE.

Appalachian National Forest Campaign

ALLEN CHAMBERLAIN, Chairman.

EMMA G. CUMMINGS,
HARRIS A. REYNOLDS,
NATHANIEL T. KIDDER,
CHARLES H. PORTER.

SEVENTEENTH ANNUAL

OF THE

SECRETARY OF THE MAS
FORESTRY ASSOCIA

To the Members of the Massachusetts For

Your Executive Committee this year ha
policy of directing the energy of the Asso
ters which seemed to demand the most
It has succeeded in carrying out much o
was laid down for this year in the pre
Some changes in policy have been made w
met with the general approval of the m
mittee would remind the members that i
entertain the suggestions of any member
or new ideas which may enable the Associ
best interests of forestry and shade tre
state.

BRANCH ASSOCIATIONS: The
Branch Associations has not been pushed
for the reason that our funds were mostly
ous legislative campaign. Only three
organized: Waltham, Plymouth and Sh
able to assist the Branches as much as in
hope to give more attention to them durin

Several of the Branches have done ex
many of them have accomplished but litt
Planting and Town Forest Contests shou
all the Branches to make an effort to h
municipalities enter these contests.

The New Bedford Branch led in accom
being instrumental in having 1410 shade

Trees planted by the New Bedford Branch; 1410 of these were planted last spring.

Ninety-foot lookout station on Copicut Hill, Fall River. Result of a movement started by the Fall River Branch.

city streets. New Bedford planted more shade trees last spring than any other municipality in the state.

Some of the Branches have complained from time to time that the proportion of money refunded to them by the main Association of the dues paid in by their members was not large enough. These complaints were generally made without a knowledge of the By-Laws which are very clear on that point. The officers cannot refund more money to any Branch than the By-Laws permit, which is twenty-five cents of the dues of each Paid-Up member.

We have in the past exceeded our authority slightly in this respect, for the sake of reducing the cost of book-keeping, and have refunded to all the Branches a sum equal to twenty-five cents for each member belonging to the Branches, whether or not they had all paid their dues at the time. A pretty large per cent. of those members failed to pay their dues and not a few resigned, hence we are forced now to follow the letter of the By-Laws and make a refund only for those members that have paid for that particular year.

We would call the attention of members belonging to Branches to the fact that those members that do not belong to any Branch receive no refund for local expenditure, and also that unless the main Association is supported, the Branches must soon become ineffective. This is first of all a state-wide organization and the assistance given the Branches now is all that the main Association can afford to do, under the present rate of annual assessment. Obviously if the annual membership fee was say ten dollars instead of two, the main organization could refund more to Branches and still exist itself. As it is, the officers of the Association must raise by public subscription, gifts and donations from one-fourth to one-half of the money needed to carry on our work over and above the amount paid as dues by our members.

We hope that this somewhat lengthy explanation is sufficiently clear to remove all further doubts in this matter, and

that the members will appreciate the fairn
Association is dealing with its Branches.

CHANGE OF POLICY: In order, so
protect our members from the "fake" tre
operating in Massachusetts, the Executi
adopted the policy of free inspection by
the trees on the estates of those member
service. Competent foresters and arborist
for this work whom the Association can rec
care to investigate the character and work
permitting them to represent the Associati
and also to follow up in various ways, the
for our members. While the Association
men for such work, the members are und
hire them after the inspections are made.

Any member can obtain this service by
questing such inspection. These cards ha
the members.

Our members understand also that the
be made only when the man assigned to
state is in their particular locality. Thi
traveling expense which neither the Assoc
could afford to give gratis should a memb
tion at a particular time. We will, howe
to make such inspections where possible at
a member, but the member must in that ca
expenses and wages of the man while enga
inspections.

The Executive Committee felt obliged
sponsibility, because of the great number
cerning poor work and extravagant char
parties who pose as tree experts. It is u
suspecting persons who have a true sentim
be humbugged by men who under the pre

the trees are really ruining many and obtaining money for doing it. A warning against these fakers has been sounded by the Association, and thanks to the press of the state, it has been brought before the people. This protest backed up by action on the part of the Association to protect its members will, we believe, raise the character of such work to a higher level and help to eliminate this fraud.

*FIELD FORESTERS:** Throughout the year we have had an average of four foresters in the field. These men solicit members, give advice on forestry matters gratis and do practical tree repair work. The great number of questions on forestry and shade tree subjects answered by them is helping to educate the public to appreciate the value of trees and to give more attention to their care.

In several instances the tree wardens have employed these men to assist them in their tree repair work and to instruct their foremen in the proper treatment of wounds and cavities and the general care of trees. We hope eventually to have a sufficient number of these foresters to supply the state with this service.

FIELD MEETING: The Annual Field Meeting of the Association was held this year in Fitchburg with an unusually good attendance. These meetings are instructive and enjoyable, and should be more largely attended. It is proposed to hold the 1915 meeting in the Arnold Arboretum.

FINANCES: Our finances, at various times within the year were very low. Business depression and the many public calamities of the year made the solicitation of funds for forestry and shade tree protection very difficult. The Executive Committee wishes to express its thanks to the many friends of the cause who by generous gifts enabled us to continue the work though the efficiency of the Association was greatly reduced from lack of funds.

*Some of our men are arborists, trained in tree repair work only, and not commercial foresters.

Tree repair work done by William
the Field Foresters. The use of s
mitted in Shade Tree Work done by

MEMBERSHIP: The followin
gain in membership for this year.

Patron Members December 1, 19
Added during year.....

Life Members December 1, 1913
Added during the year....

Resigned .....
Deceased .....

Contributing Members Dec. 1, 1
Added during the year....

Resigned .....
Deceased .....

Annual Members December 1, 1
Added during the year....

Resigned .....
Deceased .....

Club Members December 1, 191
Added during the year....

Resigned .....

Total Membership December 1,
Total Membership December 1,

Total Increase.....

PUBLICATIONS: Eight bulletins including the Annual Report were published this year and sent to all the members.

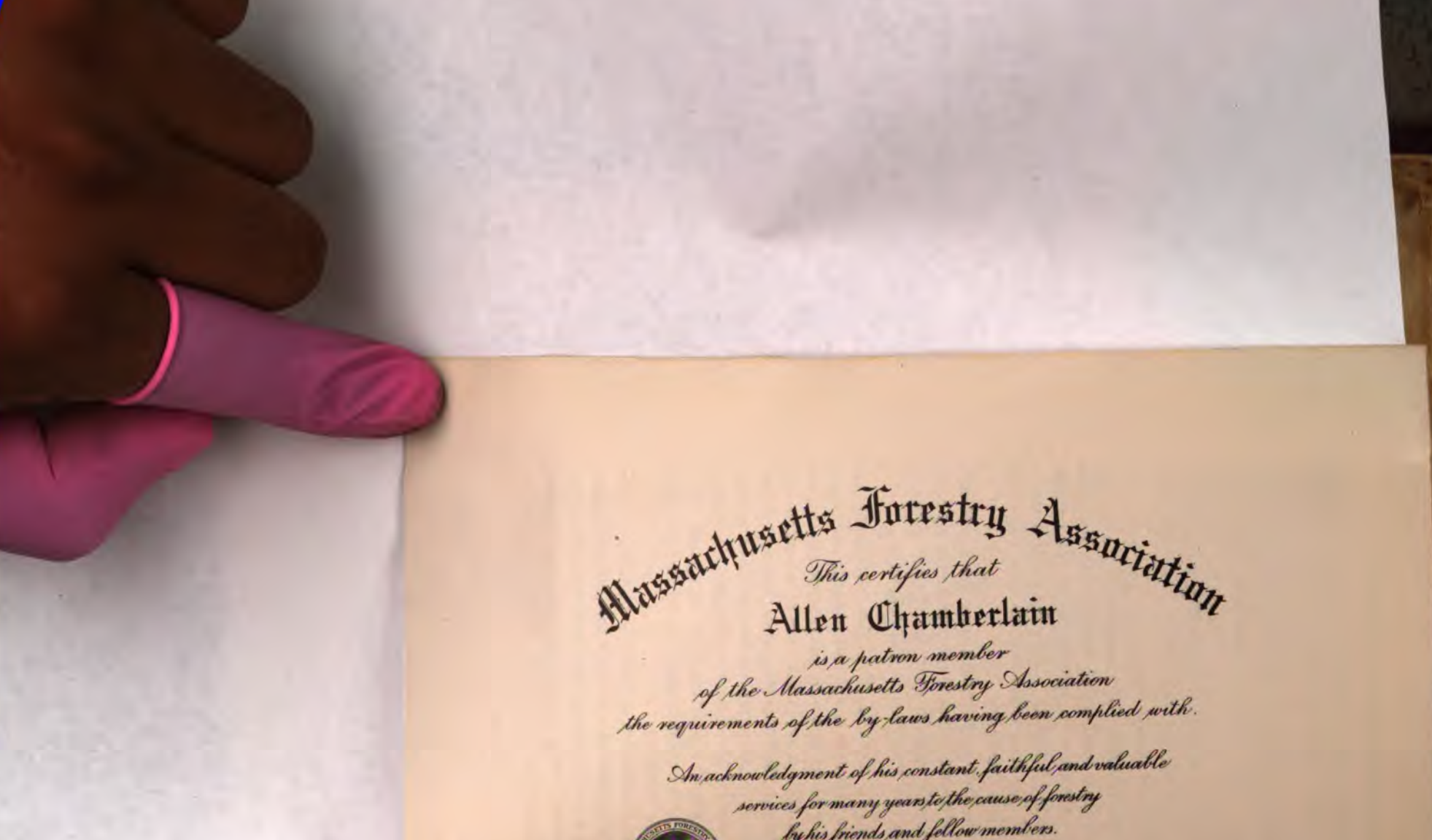
For the purpose of shade tree protection, the Association had several thousand cloth posters printed, calling the attention of the public to the shade tree laws and warning persons against injuring the shade trees. These were sold to the tree wardens at the rate of one dollar for fifty, which was below cost. One hundred and eighty-two towns and cities bought and posted these notices.

A MEMBER HONORED: The members of the Association presented a Patron membership certificate to Mr. Allen Chamberlain as a memento in recognition of his valuable services to the cause of forestry. Mr. Chamberlain was a charter member of this Association and has been one of its most constant workers ever since.

This is an unique form of memorial, since the $1,000 contributed for this certificate, which is required by the By-Laws for Patron membership, will be spent for the promotion of forestry and shade tree protection in Massachusetts.

TREE PLANTING CONTEST: The Association has tried in many ways to arouse an interest in shade tree planting, but until this year has met with meagre success. An experiment was tried last spring, in the form of a Contest and the prize consisted of the furnishing and planting of 215 shade trees, by the Association, on one mile of street or road of the city or town in Massachusetts planting the largest number of trees itself, in proportion to its population. The trees were to be planted approximately fifty feet apart, and on either side of the street.

Fifty-eight towns and cities entered the Contest, but, because of failure on the part of some to secure sufficient appropriations to make a good showing, only forty-four sent in reports. The number of trees planted by those that reported was 12,498, or practically sixty miles of street planted to



Massachusetts Forestry Association

This certifies that

Allen Chamberlain

is a patron member
of the Massachusetts Forestry Association
the requirements of the by-laws having been complied with.

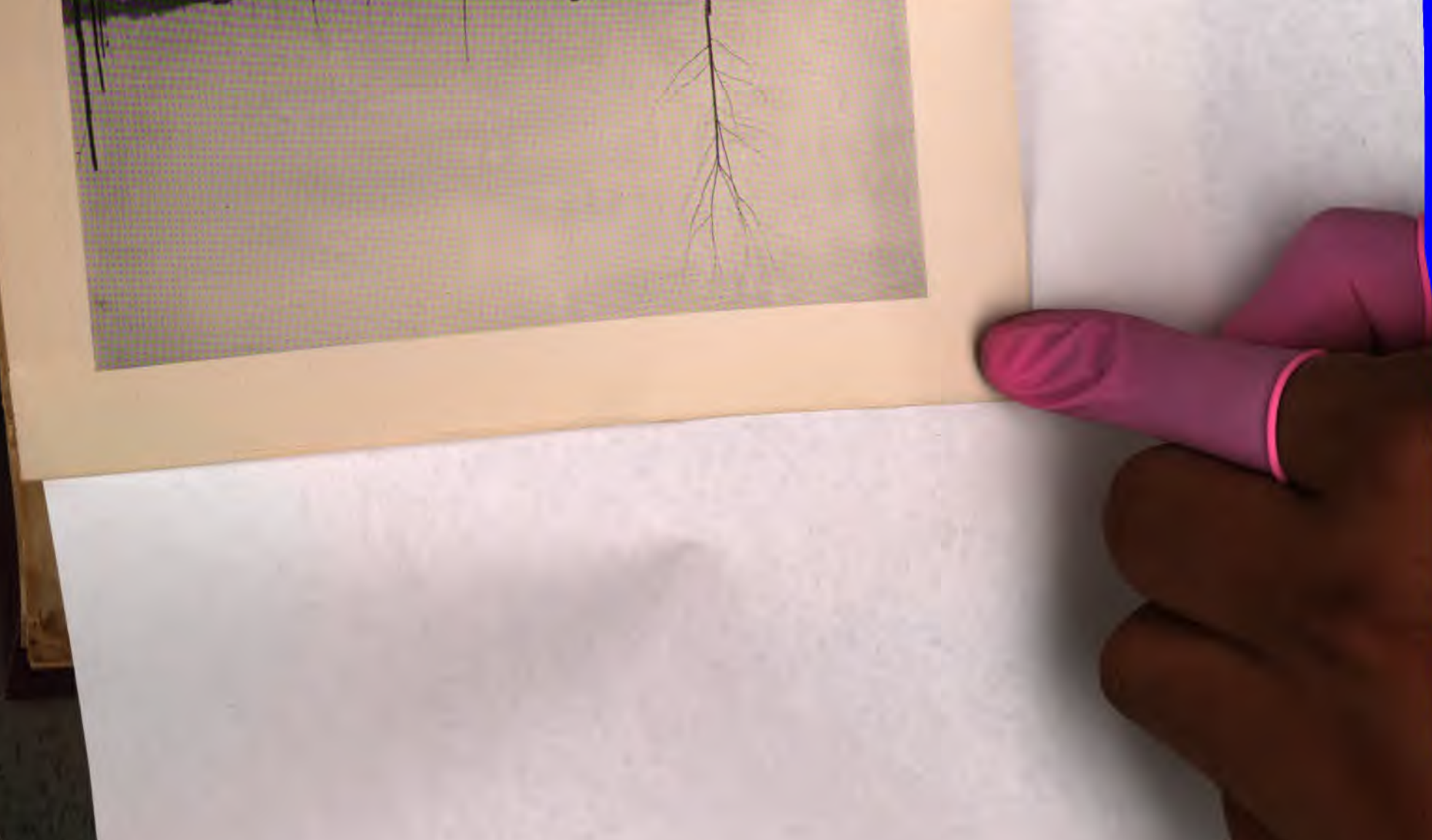
An acknowledgment of his constant, faithful and valuable
services for many years to the cause of forestry
by his friends and fellow members.

trees. The Contest was started too late for many towns to act upon the matter at the town meetings which we have learned kept some from entering the Contest.

The town of Scituate won the prize, having planted 727 trees and the prize trees were planted by the Association this fall. The specifications for the prize trees called for sugar maples with straight leaders, smooth boles, and of a size that would caliper 1½ inches at a point seven feet from the base. The trees were to be properly staked and guaranteed for one year. Competitive bids were received from several nurserymen in the state. The contract was awarded to the lowest bidder, Mr. Percival S. Brown, the Tree Warden of Scituate, who had been the moving spirit in bringing the prize to Scituate. The cost to the Association per tree planted and staked was $1.81. These trees were first-class in every way, and being nursery-grown the root systems were splendidly developed.

TREE WARDEN CONFERENCE: A conference of the Tree Wardens and City Foresters of the state was called in Worcester in April by the Association for the purpose of discussing the advisability of codifying and amending the Shade Tree Laws. Several weaknesses and conflicts in the present laws were brought to light. A resolution was passed providing for the appointment of a joint committee composed of members of the Massachusetts Tree Wardens and Foresters Association and members of the Massachusetts Forestry Association to prepare a bill to amend and codify the Shade Tree Laws. That committee was appointed and has prepared such a bill which is filed with the General Court for action by the incoming Legislature. These changes are badly needed and your representative should be requested to favor the bill.

NEW WORK: There are two things that will command the energy and the closest attention of the Association for



1915,—the Town Forest Contest and the second annual Shade Tree Planting Contest. The rules of both these contests are printed elsewhere in this report. No more practical work could be done by the Association than the actual planting of forest and shade trees. If by doing some of this work ourselves we can encourage others to do it also, we shall have accomplished the purpose for which we are organized.

This year's contest showed that for every tree that we planted, the public planted fifty-eight. The percentage will be much higher next year, and our members should see to it that their respective towns and cities enter at least the Shade Tree Planting Contest.

As to the Town Forest Contest which is absolutely new and untried, we especially desire our members in the cities and large towns to help bring their local governments to investigate this proposition. The establishment of a Town Forest is an investment and not an expenditure, and the ease with which it can be accomplished under the Public Domain Act, printed in this report, should remove all objections that might be brought against such a plan. The Association in 1913 was directly responsible for the enactment of this legislation and it is now up to the town and cities to take advantage of the privileges which it gives them.

Here is a definite proposition for our Branch Associations to work on, and we are ready to help them in every way we can. Massachusetts has a chance to lead the country in this important movement and it should do so.

Respectfully submitted,

HARRIS A. REYNOLDS,

Secretary.

4 Joy Street, Boston, Mass.

December 10, 1914.

SECOND ANNUAL TREE CONTESTS

PRIZES

There are Four Prizes, each consi
Trees to be Planted on the Public

One hundred shade trees will be plan
setts Forestry Association in each of fo
Massachusetts which win the prize in th
under the rules of contest.

For the purpose of these contests, th
the state have been divided into four gr
census of 1910.

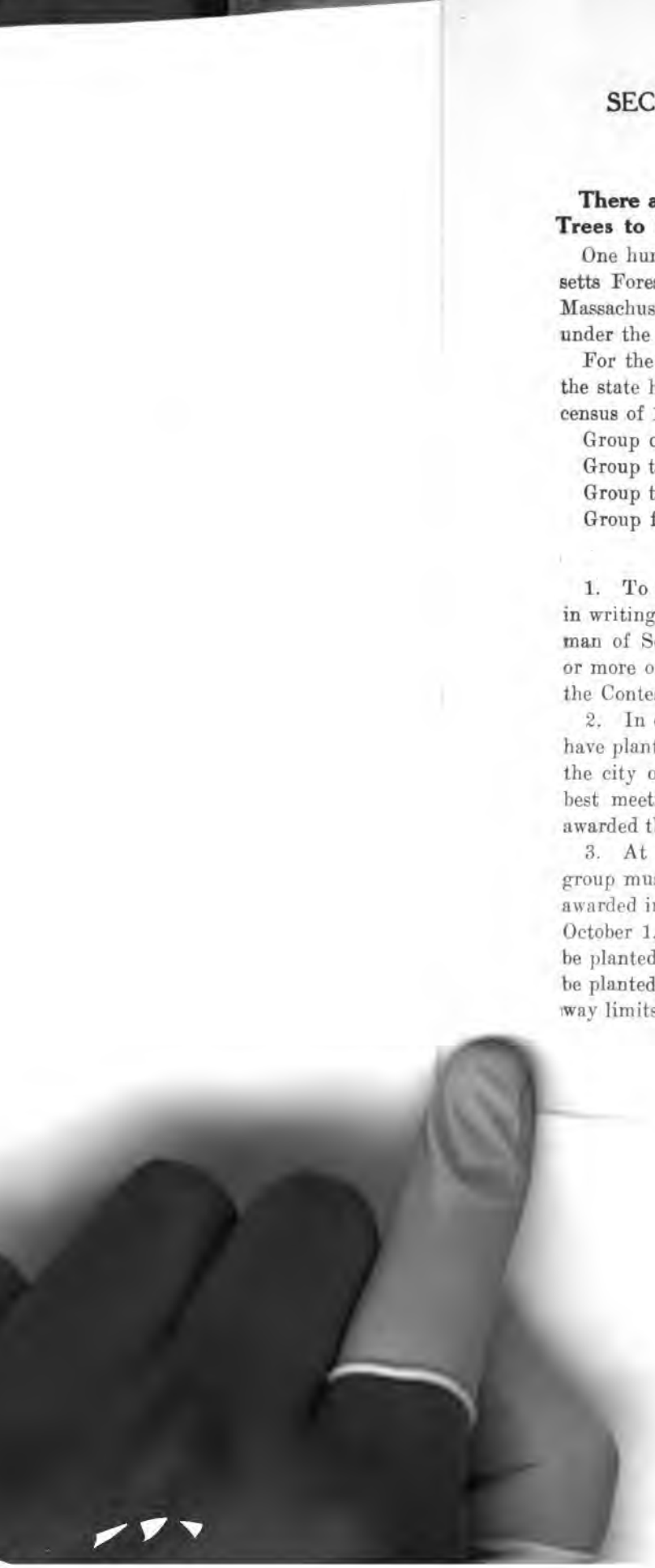
Group one includes all towns under 1
Group two includes all towns between
Group three includes all towns betwee
Group four includes all cities and tow

RULES OF CONTE

1. To enter the Contest, the Associa
in writing on or before July 1, 1915 by
man of Selectmen, the Tree Warden, o
or more organizations that the town or
the Contest. There is no entrance fee.

2. In order to enter the Contest, a c
have planted at least 100 shade trees on
the city or town planting the greatest
best meeting all the requirements here
awarded the prize, for its group.

3. At least one-fourth of the citie
group must have entered the Contest be
awarded in that group and the planting
October 1, 1914 and July 1, 1915. On
be planted on each street and where pos
be planted on private property within tw
way limits as provided by the Shade Tre



Courtesy Boston Herald.

Looking west on Willow Street, Scituate, showing a part of the mile planted to shade trees by this Association as the prize in the Shade Tree Planting Contest.

4. The prizes will be awarde
trees on September 15th, 1915, w
and reported to the Association
This provision is to eliminate tr
which have died from that or oth

5. Trees to be counted must b
and the branches of all trees shou
time of planting, but the leaders

6. A competent committee wi
ciation to judge the Contest and
of the prize trees. It will visit t
in the number of trees planted in
ing is not satisfactory, other plac
will be considered. The prizes wi
and location of the trees, the pr
and the standing of the Contesta
planted. This is to avoid giving
which plants its trees chiefly wi
The municipality planting the g
not necessarily win the prize alth
the chief considerations. The de
be final in every case.

7. The prize trees will be plan
or not later than the following sp
committee.

8. The prize will not be give
the Contest of the previous year.

Every town should have an a
annual meeting, providing for s
ing of shade trees to permit it
planting of one hundred shade
town should not cost more than
on most of the streets and
need to be staked or furnished w

6. A Committee of the Association v
during the month of September, 1915,
the 50-acre prize will be done by the A
autumn or the following spring at the d
mittee. The decisions of the Committ
land to be planted by the Association
cleared for planting by the city or tow

7. The prize will be awarded on the
the percentage given after each point
can be allowed for it.

(a) Total area and proximity o
land comprising the "For
(b) Quality of trees and of plan
(c) Advantage for lumbering, an
protection .....
(d) Possibilities for recreation an
opment .....
(e) Extension possibilities.....
(f) Fire protection measures....
(g) General improvement: roa
plans for development...

Total .....

It is evident from the conditions s
of Contest, that the Association propose
the city or town which presents the be
efficient "Town Forest" and the stro
the "Forest" will be properly protected
"Forest" may be made up of two or
is included in one tract it will be consid
than if composed of several. More la
100 acres will count in favor of the C
per cent. only can be given for area, tha

wealthy city from gaining advantage ove
that respect. It is expected that the t
with care, and the ten per cent. allowe
gives some margin for excellence.

Sections (c) and (d) emphasize the
for practical reasons. Accessibility, ea
maintenance of the "Forest," protection
the possibility of making the forest a
the landscape are all to be considered.

Section (e) is designed to keep befo
the importance of enlarging the "Forest

Sections (f) and (g) give the Cont
opportunity for enlarging their scores.
they are designed for the purpose of e
and protection which should be given to
institution of this kind should be start
without definite plans for future develo
nearly these are perfected, the better the
points.

NOTICE

**The membership of the Associa
but slightly this year and since it co
publish a register, it was decided not
this report. As very few addresses c
year, we believe that last year's regi
requirements.**

Natural regeneration of silver fir in the Communal Forest of Bornholm, Denmark. The well managed forest should reproduce itself.

ECONOMICS OF TOWN F

A town or city is a corporation given privileges by law which may be exercised v A corporation, legally speaking, is an artifici on indefinitely without regard to the indivi Such a being can enter into obligations w human beings would not be possible, becau character. One of these obligations is lo such as Town Forests. In order to consid from the business standpoint, imagine yours of such a corporation with full power to a proposition. Yours is one of 353 such corpo setts and we will suppose that it is one o area, population, and in the amount of v contains.

The best statistics obtainable concernin land in Massachusetts show that practicall nearly one-fifth of the state is waste land. about 600,000 acres of this land is assessed acre. In fact we know of one 500-acre tra cently for twenty-five cents an acre. As an contain 2500 acres of this so-called waste la nothing of commercial value except a littl and practically nothing for the town treasu In other words, a fifth of your land is a de poration.

This land is not only producing nothin chief causes of high taxes. For example Bailey owns 100 acres of land covered wi white pine assessed at $100 per acre. He man who cuts it clean. The assessor re- $5.00 an acre, because instead of coming b this land is soon covered with weed trees, alder, or scrub oak, depending upon the always remain waste land. Perhaps, there increase in value after thirty or forty years, tax be raised which formerly came from t white pine? It is simply distributed over

*Address before the Annual Meeting of the As Reynolds.

property in town causing higher taxes. That thing is happening constantly all over the state.

Another vital phase of this mismanagement of our woodlands is the high cost of living. Today it costs just twice as much for most kinds of building timber as it did sixteen years ago. If you build a house for yourself or rent one, you have to pay your share of that increase in cost of the lumber you put into it—hence, your living expenses are higher. The reason for this increase in cost is the fact that we, in Massachusetts, are importing about 87 per cent. of our timber supply, most of which could and should be raised on this so-called waste land. Our money is going out of the state to help support industries that should be located here. We know of actual instances where these industries have left our towns and have gone to other states. We pay them for producing our lumber, and the railroads for hauling it to us. With these facts as a background, we can better approach the subject of Town Forests for Massachusetts.

Since we have no Town Forests in this country in the sense that we know them in Europe, whatever we say about such forests here must be theoretical or based on practice abroad. For instance, we do not know just how much timber can be raised in a given time on a given area, although our foresters have taken accurate measurements of actual stands and have made estimates of what can be expected from certain species under average conditions.

The State Forestry Department took measurements on a great many natural and planted pine stands and estimated that for average conditions white pine grown as a crop will net at the end of fifty years a profit of something over $5.00 per acre per year. This profit is over and above the interest charge at 3½ per cent. compounded on the initial and maintenance costs. The taxes, however, are not considered. The United States Forest Service recently published a bulletin stating that "the raising of white pine to ages of from thirty-five to seventy years is a profitable undertaking at four, five, six, and sometimes ten per cent. compound interest on the investment." At these figures, when the crop was harvested, the net profit would show over $5.00 per acre per year. But to be on the safe side, let us say that it would be only $3.00 per acre. Even then, the net profit from your 2500 acres would be $375,000 in fifty years. That is not a bad investment for any town to make. The tax

rate could ultimately be reduced fifteen to t
by such an undertaking.

The laboring class would be benefited by
some of the European forests steady employr
man for every fifty to seventy-five acres. On
oped town forests, that of Zurich, employs
around for every thirty-three acres. But i
only one man for every 100 acres, you would
a little permanent industry employing tw
work for more at certain seasons of the yea
beginning you could employ from ten to fift
lem of the unemployed can be partly solv
cause much of the work to be done requires
which any man can do. The building of ro
ning, planting, logging and the like, can all
workmen.

The number of men employed in this
time does not depend on the current demand
duced. Therefore more men can be employ
another without loss to the business. Plan
forward or held back at will. Lumber saw
demand increases in value as it seasons. W
in town are running slack, citizens who rea
be employed in the forest. The farmers in
work for their teams and men in winter in t
partially eliminating a great economic loss.

Another policy which is already bein
state and which could be adopted to adva
istration of Town Forests is the use of c
term prisoners can be put to work in a tow
way the expense of keeping them can be gr
entirely eliminated, and the health of the
well as the forests. These prisoners can
good health, ready for hard work and with
pockets.

Tubercular patients could be given ligh
forest, which would be a blessing to suc
often find it difficult to obtain suitable em
cases this would save the expense of maint

Wood-using industries would again be at
which would mean more money and more
tion would be assured fuel for the future a

There are many other ways in which
from a town forest. If the forest is locat
and about the reservoir, the water itself wi
ing through the floor of the forest. The re
to be cleaned so frequently, because the si
hillsides. We know of towns in which the
voir is a regular expense every few years
from erosion would be stopped.

Every city and most large towns have
tained at the cost of thousands of dolla
there is from one to four of such parks.
can be had than a town forest. The for
Therefore with such a forest, you can red
priations from one-fourth to one-half. The
rope are generally more popular as recre
neatly kept formal parks.

Property adjoining or located near to
of this kind is nearly always higher in val
erty in less favored sections of a muni
establishment of such a forest would al
crease property values in the vicinity of
quently the income to the public treasury

As the population increases, the val
more rapidly than improvements. This
earned increment. It has made many m
annual increment for fifteen years prior to
One piece of land here in Boston increased
in twenty years. Property values increas
lesser degree. Why should not your town
benefit? Why shouldn't all the people ge
of the chosen few, who happen to be lan
landholding grandfathers? By owning a
crement in value would go directly to the

This property is sure to increase in
It is a well-known fact that the forest im
the soil. The chemical analysis of wood
per cent. carbon, forty-two per cent. oxyge
gen, one per cent. nitrogen and one per cen
the exception of the mineral ash, the othe
wood are taken chiefly from the air and w
fall from the trees form humus in which
are generated. The mineral substance co

which makes the surface soil more productive is obtained from deep down in the soil, where it is absorbed by the rootlets of the tree. The tree is an agency for bringing plant food from the deep sub-soil to the surface. Your forest will therefore act as a fertilizing medium to your land making it more valuable, for other crops. If the time ever comes when this land must be used for houselots, it will certainly sell for more than $5.00 an acre and the town will get the benefit.

The value of a forest to a community is felt in many ways which cannot be estimated in dollars and cents. A large forest makes a splendid windbreak for a town. It tones down the harshness of the winter storms. It cools the breezes of summer, and helps to purify the air we breathe. It enhances the beauty of the surroundings which today is no small item when, summer residents and tourists are so plentiful. Millions of dollars are brought every year into New England by tourists from other parts of the country. Your town can share this business by making itself more attractive.

A large town forest will make an excellent game preserve. The forests of the old world are used for this purpose. Bird sanctuaries can be established on these areas which will soon cause our forests to be repopulated with warblers that will help reduce the insect pests. The value of none of these things can be estimated in money and yet everybody will concede that they have a real value. The desolate appearance of large areas in this state at all times and especially in winter is deplorable, and the only solution to the problem seems to be public utilization which can best be done by planting trees for profit.

All of these arguments for town forests while theoretical, so far as this country is concerned, have been proved practical in the Town Forests of Europe. Of the ten principal forests visited by the speaker in Germany and Switzerland, the average net profit per acre, annually was $6.20. The forest showing the greatest profit, was Forbach in Baden, which nets $12.14 per acre yearly from its forest. The town has a population of 1900 and owns a forest of 1482 acres. The citizens have no taxes to pay and nearly $10,000 are divided yearly among 275 of its families oldest in time of residence. The average town in Massachusetts has a population of 4100 and 2500 acres of waste land just about double the proportions in Forbach. It is said that 1500 villages in Germany have their own forests, which pay all or a great part of the taxes. Nearly all the European countries have their town

forests. The town of Orson in Sweden h
its taxes, supports its public schools and
street railway.

As to the employment given the citi
many cases a large per cent. of the popula
forest or subsidiary industries. Many wo
in the summer and in the town forest in
stant demand for timber and there are n
to throw them out of employment. A mo
people can scarcely be found than in tho
of people, men, women and children, are t
ing trips through these forests. The value
public health is inestimable. Hotels are
larger Town Forests and all of them mai
inns. Considerable money is spent by s
tection and propagation of birds in these
chiefly to protect the forests against insec
might be greatly simplified by this mean
deer and other game even in densely po
very fact that the people know that they
from the forests, popularizes them and
One of the finest things about the whole id
are being produced on lands too steep or o
crops. It is the very essence of cons
democracy.

To sum up the advantages of the tow
ment paying from four to six per cent.; i
try; it is a wild park; it protects and co
ply; it is an improvement and protection
the people from the extremes of clim
surroundings, purifies the air and wate
to the town against greedy exploitatio
area.

The economics of Town Forests are
ments in favor of them, I believe, are un
possible to reduce to money values all
would accrue to a town and its people f
would not be many years until the great
servation we have ever seen would be o
Our national forests are large areas, but t
with the aggregate of waste land through
should be producing forests, and which

near the markets as to make it much more valuable for timber growing than the lands of the National forests.

The 60,000 young white pine trees to be planted as a prize by this Association on fifty acres of the town forest of the municipality making the best showing in the establishment of a town forest this coming year ought to be some incentive for action by many of our towns and cities. We hope that you will make an effort to interest your respective communities in this movement.

ATTENTION OF MEMBERS

If you are interested in books pertaining to shade trees, here are two that we would specially recommend. They may save you considerable money and your trees as well if the advice contained in them is followed. They are excellent reference books.

SHADE TREES IN TOWNS AND CITIES (Solotaroff)
PRACTICAL TREE REPAIR (Peets)

The former retails at $3.00, the latter at $2.00. By a special arrangement, the Association can mail you both of these books for $3.50, or the first named for $2.20 and the second for $1.40. We shall be glad to send you either or both. If you take both, we can save you $1.50 and the trouble of buying them elsewhere.

ORGANIZATION AND MAN
TOWN FOREST

Before we can organize and manage a
and most important problem is, how ar
forest? In many cases it will be difficult
already covered with timber. Denuded
purchased and planted. In this case it
obtain any immediate returns from your f

There are a number of ways of obt
and most generally used plan would be t
shed area. Most cities and towns have a
lands on the watersheds for the purpo
water supply and these are generally in
ment. Where this area is already owned
of title or an amicable arrangement with
for the use of the land is the best start fo

Providing there is no available wate
to obtain more land than the watershed
would be to consult your assessors' lists.
have been or are about to be sold for ta
and if desirable bid them in. For obtai
tional lands, this is one of the most desira

If you can persuade your Selectmen
proposition is a feasible one and a good in
will appropriate money enough to enable
market and buy good land, thereby getti
towards obtaining the ideal Town Forest.

You may also be able to interest some
who wishes to leave a monument to hims
he is gone and who will donate the land
governing the acquisition of land for town
legal and is the quickest way of getting a

Other ways and means will suggest th
you get ready to start on the proposition
been suggested in a recent bulletin of thi

I have outlined several ways of obtai

---

*Address before the Annual Meeting of th
W. Colton.

as town forests, but have not touched as yet on the most vital point which is, getting the consent of your city or town officials to accept the idea. This will be the hardest part of the whole proposition and to facilitate the work I should advise, by all means, the establishment of a branch of the Massachusetts Forestry Association in your town. Then get it to spread information broadcast among your voters and influential people. If you can obtain even a little appropriation or a small area of land to start work on, it will do admirably as an entering wedge. With a few years' practical work on even the smallest area, it becomes much easier to convince skeptics of the practicability of the project.

The size of the area obtained by various towns and cities will, of course, vary greatly from less than a hundred acres to a thousand or more. The ideal area would be nothing less than a thousand acres but as I have said before a much smaller one would be very acceptable for a start and should not be scoffed at.

In order that I may convey to you in as practical a manner as possible, the working out of a plan of management for a town forest I am going to create a theoretical town forest.

Let us suppose now that the town does not control a watershed area but has through one or more of the methods previously presented, acquired an area of one square mile or 640 acres. The land is an isolated block situated in a remote section of the township but connected with the village by a good road, thus giving it a proper outlet for its products. The area is made up of several old farms, containing a diversity of forest types and open pasture land.

Our first requirement is to become thoroughly familiar with the territory. In order to do this, we must first of all have the land surveyed and the boundaries permanently marked. When this is done a topographic map should be prepared. This can usually best be done, especially in towns by a civil engineer as this will obviate the necessity of the town's investing in expensive surveying instruments for a small job.

When this is completed, the work of the forester commences. He must add to his topographic map, a complete timber map showing the character of timber and other growths on the land. While he is doing this work, he is placed in a position to become thoroughly acquainted with his area. He will know where every brook, swamp, path, road or trail is located and will also be pretty well posted on the character of the soil.

With the timber map finished, we find the area to be divided as follows:

Water	5	acres
Open pasture and meadow land	100	"
Brush, swamp and waste land	165	"
Sprout hardwoods, 10-30 years' growth	100	"
Mixed hardwoods, 20-40 years' growth	120	"
Mixed hardwoods, 40-60 years' growth	50	"
Pine and hardwoods, 40-60 years' growth	60	"
White Pine, 20-40 years growth	30	"
White pine, 40-60 years' growth	10	"
Total	640	acres

The next thing to do is to make a working plan for the forest. To do this, we must in addition to the above table make an estimate of the amount of timber of each type.

After consulting yield tables and working out the time at

White pine planted twenty years ago on the Fresh Pond watershed, Cambridge, Mass.

twenty acres mature and ready to harv
and two hundred and fifty acres of ma
only thinning.

In order to make a rotation for wo
take into consideration the number of
that can be cut yearly, and yet not ex
and the amount to be planted and thin

With one hundred and twenty ac
would be safe to plan on cutting clean t
an estimated stand of thirty thousand
acre, which would be only a fair stand,
three hundred thousand feet which
amount for which it would pay to set
Cutting at this rate, we would cover
during which time the two hundred
waste land plus that cut off each year
planting an average of thirty acres per
twelve years a portion of the remainin
acres would be ready for harvesting and
ing on the same plan for this class
twenty-five years making a total of th
years could now be utilized in thinning
thirty-seven years ago at the end of
block of pine, if pine had been used, w
another block each succeeding year. It
desirable to cut the whole of the thirty
would exhaust your stand too soon. It
to create a new rotation based on the a
wood then standing. In this manner,
rotation of crops and continuous work

If additional areas of land should
of time, they should be treated as se
were too small for that, in which case
the first and the plans expanded to me

This sketch is, of course, only a s
be done under ideal conditions. There
tion of markets, fire hazards, labor tr
eases and many other minor matters
crop out.

In the first place, I have reckoned
harvesting of the crops. During the
many things must be done for the ins

our carefully planned scheme. When the original survey is made, the boundaries should be carefully marked and notations of all old roads, paths, etc., made on the plan. One of the first duties thereafter would be to create a fire line completely encircling the area, or at least wherever the chance of fire spreading from other territory is even slight. Next, all old roads and paths should be cleared and kept cleaned, more paths and trails should be made, and gradually, as time progresses, certain roads improved, so as to make all parts of the tract easily accessible even for heavy wagons.

The more the tract is cut up by paths, roads and trails, the better is its protection from total destruction by fire. If the forest is divided into twenty or thirty small areas bounded by these paths and roads, the chances are that should fire start in any one, it could be confined to that particular area, thereby saving the rest of the forest. In this way the fire hazard is reduced twenty or thirty times, according to the number of divisions maintained.

A portion of the open land should be set aside for a small nursery in which to keep a stock for refilling such gaps as may appear in the plantations from time to time. This nursery should be stocked principally with one or two-year-old plants bought from some large, dependable nursery, as this is much cheaper than trying to raise them from seed yourself. A few seeds may be sown for experimental purposes or for exhibition.

A tool house and workshop should be erected, and a caretaker should reside permanently on the tract if possible. This will be found very essential, especially if the idea of opening the area to the public for a great outdoor recreation park is carried out as advocated by many as an adjunct to the town forest.

In carrying out the work as outlined in the foregoing plan, it would give employment to about five men the year round, and to from five to ten men all winter.

The permanent employment of a number of men summer and winter would obviate the necessity of maintaining a fire patrol during the summer. Emergency stations should, however, be established at advantageous points throughout the territory, and during the dangerous season one man should be delegated to go to some point of vantage several times a day, and look for signs of fire. A telephone should be installed, and arrangements made to keep in close touch with the state fire lookout stations.

Using the preceding sketch as a co
you will be able to form an idea of th
forest of any size. Of course, the co
vary so greatly in various parts of th
ances would have to be made for them.

I presume one of the first question
we going to afford a professional fore
and we presume one would be necessar
outlined by you. My answer is that i
but very desirable. As has been expla
from this office outlining the state law
and forestry matters in general, the st
to make plans and manage the forest
I believe, however, that the time is co
either, when every city and large town
that groups of towns will band togethe
employing a trained forester to look af
shade tree interests.

THE ENDOWMEN

It requires but $50 to become a L
ciation. That money goes into the Pe
not be spent by the Association, but t
toward its support. This fund is entir
demonstrated during the past year, bec
depression, organizations of this kind a
becoming a Life member you will elimi
annual bill, as well as help to reduce t
ation in bookkeeping. We want to b
this year, which will require about
Will you be one of that number?

Mt. Adams and Mt. Madison from Pinkham Notch road. Land now included in the National Forest in the White Mountains.

WHITE MOUNTAIN NATIONA

BY ALLEN CHAMBERLAIN

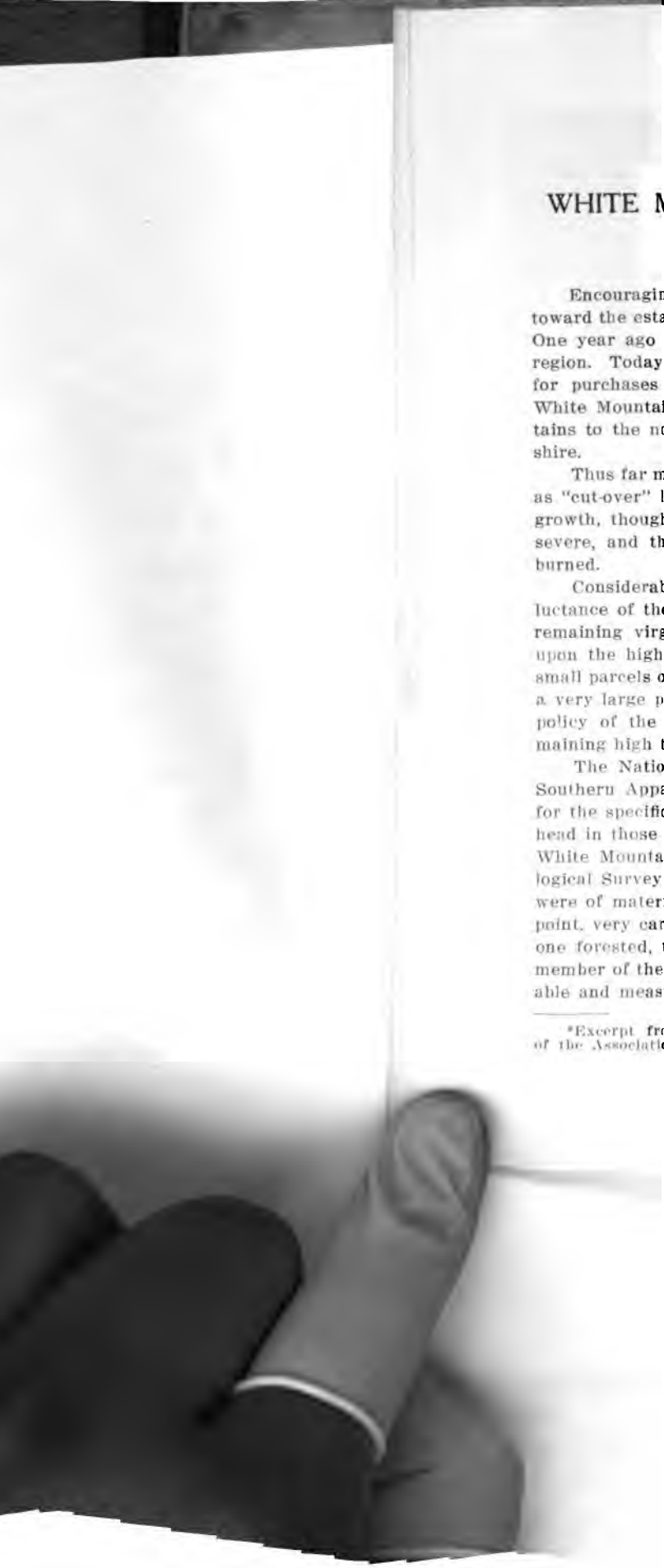
Encouraging progress has been made dur
toward the establishment of the White Mountai
One year ago the government owned but 100
region. Today it has possession of 220,000 ac
for purchases contemplates about 600,000 a
White Mountains, and about as much more in
tains to the north, and lying both in Maine a
shire.

Thus far most of the acquisitions have beer
as "cut-over" land. A great deal of this bear
growth, though there are areas on which the
severe, and there are some tracts that have
burned.

Considerable disappointment has been felt
luctance of the Forest Reservation Commissio
remaining virgin forests in the mountains, n
upon the high steep slopes. This year, howe
small parcels of such timber have been bought
a very large purchase of cut-over land, and it
policy of the Commission will hereafter be
maining high timbered slopes before they are

The National Forests, both in New Ham
Southern Appalachian mountains, were autho
for the specific purpose of protecting the flow
head in those regions. Before any lands were
White Mountains the law required that the U
logical Survey should determine definitely tha
were of material importance to the streams.
point, very careful studies were conducted on
one forested, the other denuded, and it was
member of the Survey, that "the forest cover
able and measureable degree, steady and regu

*Excerpt from an illustrated address before
of the Association.



"Cut-over" land on the Rocky Branch of the Saco River now included in National Forest in the White Mountains.

In view of this fact it would seem t
the manifest intent of the Weeks Law,
acquire the remaining high forest befo
Present logging methods in that secti
stripping of all steep slopes, a practic
leads to permanent barrenness through
soil thus exposed.

By the terms of the Weeks Law t
undertaking expires on June 30, 191
$8,000,000 which were provided, $6,300,0
the remainder will be exhausted before
date have cost $4,700,000 in the South a

The purchased lands both North
thus presenting a difficult problem in e
and, moreover, they represent such a
watersheds that it is sought to protect,
the undertaking is far from being achie
ject at this stage would be highly wast
fore been asked to extend the appropr
to allow an increase in the annual all
$4,000,000.

This Association played an impo
secure the passage of the Weeks' Act,
which is about expended. The new bi
for the extension of appropriations fo
meet with considerable opposition and
tion to help secure more appropriations

The funds we now have on hand
is not very large and should the occa
assistance we would not be in a posi
port, therefore, any contributions made
fund will be spent for a good cause. W
work to lapse since such a splendid sta
The land obtained for National Forests
is only one-sixth of what should be
should not allow this work to be disco

PINE BLISTER RUST

By H. T. Fernald, State Nursery Inspector

The present condition of Massachusetts as regards the Pine Blister Rust may fairly be considered encouraging. The disease has apparently now been eliminated from all stock in the nurseries of the state, though careful inspection of pines at all these places will be continued each spring. No five-leaved pines are now allowed to enter this state from abroad, and the only element of danger remaining, is from pines growing on different estates, planted there before the disease was known. Every such planting is being carefully inspected each spring, and all diseased trees found are pointed out to their owners for removal. The owners with perhaps one or two exceptions are actively cooperating in the work. Currants and gooseberries within 500 yards of infected pines are removed, and it is now only a question of keeping these two kinds of plants apart until all the diseased pines shall have been found as the infection becomes evident, and of destroying them. It now seems that the disease should be completely stamped out within five years, and probably sooner, unless plantings of infected pines of which no information has been received are involved, and every effort has been made to locate all plantings in the state since 1900, trace the source from which the trees came and examine all of dangerous or even doubtful origin.

This disease ultimately kills every tree it attacks, but may be present for several years before it shows externally. When it breaks through to the outside it produces spores which cannot start the disease on another pine, but can do so on currants or gooseberries. Here it attacks the leaves, and in the fall produces spores which can infect the pines. Accordingly, pines, and currants and gooseberries must be kept away from each other.

The members of this Association can do a great deal to help stamp out this disease by reporting either to this office, or to the State Nursery Inspector at Amherst, all plantations of white pine that have been made, either by themselves or other parties within the past ten years. We should make every effort possible to destroy all plants affected with this disease before it gains a real foothold in this state. Because of the fact that white pine is our principal commercial tree, this disease is one of the greatest menaces with which the state is confronted.

BIRD SANCTUA

The United States Department of Ag
over three-quarters of a billion dollars
farm and orchard products in this cou
pests. It is claimed that this tremendo
to the lack of normal bird life. The dama
trees here in Massachusetts is enormou

If by protecting the wild birds and
conditions for their propagation we can
of the state, we will be doing a great dea
and shade trees. Many of our membe
private plantations that would make ide
this reason, they should be familiar wi
viding for Bird Sanctuaries, Chapter 410

Under this law, the individual ma
hunt or to permit hunting on his plac
help from the state in maintaining such
agreement with the state is made throu
on Fisheries and Game. Their offices a

The agreement is one which might
time and does not constitute a lien on
as possible, the commissioners will help
on your estate, plant food-producing sh
the birds with your consent, and even g
erating certain species on your property,
priations and the supply will permit. Thi
and we hope that our members will avail
portunity to increase the bird life of the
or nothing to make this arrangement and
to bring considerable profit as well as sa
try it. Won't you give this your attenti
gin to return next spring? We shall be g
way we can.

For those who might be interested i
the following parties are some of the ma
kinds of boxes: Philip E. Perry, P. O. B
The Audubon Bird-House Co., Meriden,
ard, Canton, Mass.; E. C. Ware, Wareh
White, Box 45, Kenilworth, Ill.

AN ACT RELATIVE TO PUBLIC DOMAIN.

(Acts of 1913. Chapter 564.)

Be it enacted, etc., as follows:

Section 1. Section twenty-three of chapter twenty-eight of the Revised Laws is hereby amended by striking out the word "a," before the word "town," in the second line, and inserting in place thereof the words:—an annual,—by inserting after the word "therefore," in the eighth line, the words:—but the indebtedness so incurred shall be limited to an amount not exceeding one-half of one per cent. of the last preceding assessed valuation of the city or town,—and by striking out the words "commonwealth for the benefit of the," in the eleventh line,—so as to read as follows:—*Section 23.* A town, by a vote of two-thirds of the legal voters present and voting at an annual town meeting, or a city in which the city council consists of two branches, by a vote of two-thirds of the members of each branch, and a city in which there is a single legislative board, by a vote of two-thirds of the members thereof, present and voting thereon, may take or purchase land within their limits, which shall be a public domain, and may appropriate money and accept gifts of money and land therefore; but the indebtedness so incurred shall be limited to an amount not exceeding one-half of one per cent. of the last preceding assessed valuation of the city or town. Such public domain shall be devoted to the culture of forest trees, or to the preservation of the water supply of such city or town and the title thereto shall vest in the city or town in which it lies.

Section 2. Said chapter twenty-eight is hereby further amended by striking out section twenty-five and inserting in place thereof the following:—*Section 25.* The city or town forester in each city or town, with one or more keepers appointed by him, shall have the management and charge of all such public domain in that city or town, and within such public domain shall have the power of constables and police officers in towns. But a town by a vote of two-thirds of the legal voters present and voting at an annual town meeting, or a city in which the city council consists of two branches, by a vote of two-thirds of the members of each branch, and a city in which there is a single legislative board, by a vote of two-thirds of the members thereof present and voting thereon, may place all such public domain

within its limits under the general supe
the state forester, who shall thereupon, u
of, make regulations for the care and use
and for the planting and cultivating of
city or town forester in such case and
supervision and direction of the state for
with the duty of enforcing all such regul
ing such labor therein as may be neces
maintenance thereof; and within such pu
the powers of constables and police office

Section 3. Said chapter twenty-eig
amended by striking out section twenty
place thereof the following:—*Section 26.*
may lease any building on a public doma
sums derived from rents or from the sa
such domain, so far as may be necessar
thereof.

Section 4. Said chapter twenty-eig
amended by striking out section twenty-
place thereof the following:—*Section 27.*
which such a public domain is situated
building for public instruction or recrea
such public domain has been placed und
control of the state forester, under the
no such building shall be erected unless
be obtained.

Section 5. Said chapter twenty-eig
amended by striking out section twenty
place thereof the following:—*Section 29.*
fraying the expenses incurred under the
preceding sections any city or town ma
time, and to an amount not exceeding the
for the taking or purchase of lands fo
bonds or notes. Such bonds or notes sh
the face thereof the City or Town of
Domain Loan, Act of 1913; shall be payab
ments, beginning not more than one yea
of, as will extinguish each loan within
date; and the amount of such annual pa
any year shall not be less than the amou
said loan payable in any subsequent y
issue of bonds or notes shall constitute

bonds or notes shall bear interest at a rate not exceeding four and one-half per cent. per annum, payable semi-annually; and shall be signed by the treasurer and countersigned by the mayor of the city or, in the case of a town, shall be signed by the treasurer and countersigned by the selectmen. The city, by its mayor and treasurer, and the town, by its selectmen and treasurer, may sell such bonds or notes at public or private sale, upon such terms and conditions as they may deem proper, but the bonds or notes shall not be sold for less than their par value; and the proceeds shall be used only for the purposes herein specified.

Section 6. The city or town shall at the time of authorizing said loan, or loans, provide for the payment thereof in accordance with the foregoing provisions of this act; and when a vote to that effect has been passed by the city council, or at any annual town meeting, a sum which will be sufficient to pay the interest as it accrues on the bonds or notes issued as aforesaid by the city or town, and to make such payments on the principal as may be required under the provisions of this act, shall, without further vote, be assessed by the assessors of the city or town annually thereafter, in the same manner in which other taxes are assessed, until the debt incurred by said loan, or loans, is extinguished.

Section 7. This act shall take effect upon its passage. [*Approved April 26, 1913.*

AN ACT TO ESTABLISH A STATE FOREST COMMISSION AND TO PROVIDE FOR THE PURCHASE OF LANDS FOR STATE FORESTS.

(Acts of 1914. Chapter 720.)

Be it enacted, etc., as follows:

Section 1. There is hereby established a state forest commission, to be composed of three persons, one of whom shall be the state forester and two other members who shall be appointed by the governor, with the advice and consent of the council, and who shall serve without compensation. The term of office of the appointive members of the commission shall be six years, except that when first appointed one of the members shall be appointed for six years and one for three years. Thereafter one member shall be appointed every third year.

Section 2. The commission shall h
the Commonwealth by purchase or othe
land or land suitable for timber cult
monwealth. The commission may, aft
or exchange any land thus acquired w
the commission can no longer be used
purposes of this act. The average co
the commission shall not exceed five d

Section 3. Lands acquired under t
shall be known as state forests and sh
and management of the state forester.
forest and develop such lands and shall
reasonable regulations which in his
crease the public enjoyment and benef
tect and conserve the water supplies
The state forester shall keep and sha
report an account of all money invested
of the annual income and expense the

Section 4. In the reforestation, m
ment of lands purchased under this a
far as it is practicable, shall obtain th
fore under the provisions of chapter six
of the acts of the year nineteen hundr
in amendment thereof and in addition

Section 5. Land acquired under th
shall be exempt from taxation; but
reimburse cities and towns in which su
taxes lost by reason of their acquisition,
to the same extent as in the case of
institutions under the provisions of
seven of the acts of the year nineteen

Section 6. The sum of ten thous
pended during the present year and the
dollars may be expended annually for
by the state forest commission in the a
the provisions of this act: Provided,
may, at its discretion, authorize the st
part of said sum in the maintenance o
of said twenty thousand dollars rem
close of any year, the balance may be
year. The said commission may also

five hundred dollars annually for its necessary expenses incurred in carrying out the provisions of this act.

Section 7. This act shall take effect upon its passage. *[Approved June 20, 1914*

AN ACT RELATIVE TO THE DISPOSAL OF SLASH OR BRUSH FOLLOWING WOOD OR LUMBER OPERATIONS.

(Acts of 1914. Chapter 101.)

Be it enacted, etc., as follows:

Section 1. Every owner, tenant or occupant of land, and every owner of stumpage, who cuts or permits the cutting of wood or timber on woodland owned or occupied by him or on which he has acquired stumpage by purchase or otherwise, and which borders upon the woodland of another or upon a highway or railroad location, shall clear the land of the slash and brush wood then and there resulting from such cutting for such distance, not exceeding forty feet, from the woodland of such other person, highway or railroad location as the local forest warden shall determine, and within such time and in such manner as he shall determine.

Section 2. Any person who cuts or causes to be cut trees or bushes or undergrowth within the limits of any highway or public road shall dispose of the slash and brush wood then and there resulting from such cutting within such time and in such manner as the forest warden of the city or town wherein such cutting is done shall determine.

Section 3. Whoever neglects to comply with the directions of the forest warden with regard to the disposal of slash and brush, as provided in sections one and two of this act may be punished by a fine of not less than five dollars nor more than fifty dollars.

Section 4. This act shall take effect on the first day of January in the year nineteen, hundred and fifteen. *[Approved February 25. 1914.*

REVISED SHADE TREE LAWS.

The Association is presenting but one bill to the legislature this year which comprises the codification and the amendment of the shade tree laws. We have found that there are many conflicts in the shade tree laws as they stand at present, and

that they have many weaknesses which are not to the best i
terest of the shade trees.
Won't you kindly speak to your representative to favor t
bill? It is really not new legislation but merely a bill to co
and simplify the present laws.

The Association maintains a library on forestry subjects
list of our books and pamphlets are given below. Any memb
the privilege of referring to this library at his convenience.

BIBLIOGRAPHY

FORESTRY MAGAZINES:

American Forestry:
1. "The Forester"
   Vol. I-VII-1895-1901 incl.
2. "Forestry and Irrigation"
   Vol. VIII-XIII-1902-1907 incl.
3. "Forestry and Irrigation and Conservation"
   Vol. XIV-1908
4. "Conservation"
   Vol. XV-1909
5. "American Forestry"
   Vol. XVI-XIX-1910-1914 incl.

Forest Quarterly:
Vol. I-XI-1902-1914 incl.

Woodland and Roadside:
Vol. I-VII-1902-1909 incl.

STATE FORESTRY REPORTS:

Alabama, Alaska, California, Iowa, I
tucky, Maryland, Michigan, Missouri, M
Minnesota, New York, New Jersey, Ne
Pennsylvania, Rhode Island, Virginia, Ve
Virginia.

*Includes: Agriculture of Massachuset
Massachusetts Board of A
The Gypsy Moth—Forbus

BIBLIOGRAPHY

FOREIGN AND TERRITORIAL:

Canada (General), Hawaii, Labrador, Nova Scotia, Ottawa, Ontario, Quebec.

UNITED STATES DEPARTMENT OF AGRICULTURE:

U. S. Year Book 1899-1902 incl.

U. S. Deep Waterways Association Report 1896.

U. S. Geological Survey Annual Reports.

(a) Irrigation,
(b) Hydrography, 1889-1900 incl.
(c) Forest Reserves,

National Conservation Commission Reports, I-II-III.

Report of the Fifth National Conservation Congress.

Special Governmental and Experimental Station Reports on Injurious Insects.

OTHER BOOKS PERTAINING TO FORESTRY:

Lumbering:

American Lumber Industry.....
.....National Lumber Manufacturers' Association

National Problems Affecting the Lumber Industry..
.....National Lumber Manufacturers' Association

Trees:

Cambridge Biological Series—Vol. III.....H. Marshall Ward
Future Forest Trees.....T. Fisher Unwin
Forest Trees and Forest Scenery.....G. Frederick Schwarz
Handbook of the Trees of the Northern States and Canada.....Romeyn Beck Hough
Manual of the Trees of North America.....
.....Charles Sprague Sargent
Practical Tree Repair.....Elbert Peets
Shade Trees in Towns and Cities.....William Solotaroff
Longleaf Pine in Virgin Forest.....G. Frederick Schwarz
Studies of Trees in Winter.....Annie Oakes Huntington
The Timber Pines.....Mohr and Roth
The White Pine.....Spalding and Fernow
The Tree Book.....Julia E. Rogers
Trees and Shrubs of Massachusetts.....George B. Emerson
Trees of New England.....Dame and Brooks

General Forestry:

Economics of Forestry....
Forestry in New England.
North American Forests a
Practical Forestry.....
Principles of American Fo
Proceedings of American
.....
Schlich's Manual of Forest

Miscellaneous:

Arbor Day.....
Arbor Day.....
Earth Features and Their
Field Book of American W
Forestry in Minnesota....
First Studies of Plant Life
Gardens and Their Meanin
Introduction to Botany....
Lands of the Arid Region.
National Parks.....
Nature Study and Life....
The Brown Tail Moth.....
Useful Birds and Their Pr

Our library, while it con
books, should be greatly enlar
portant works on forestry wh
tain from lack of funds. We
volumes of recent works on fo
that our members will send u
duplicates that are not already

We hope that our members
future than they have in the p

CHARTER

Commonwealth of Massachusetts

Be it known that whereas JAMES H. BOWDITCH, D. BLAKELY HOAR, ALLEN CHAMBERLAIN, JOSEPH S. NOWELL, WALTER C. WRIGHT, MYRON S. DUDLEY, WARREN H. MANNING, FREDERICK L. OLMSTED, JR., and JACOB U. PIERCE have associated themselves with the intention of forming a corporation under the name of the

MASSACHUSETTS FORESTRY ASSOCIATION

for the purpose of introducing judicious methods in dealing with forests and woodlands, arousing and educating a public interest in this subject; promoting the afforestation of unproductive lands; encouraging the planting and care of shade trees, and establishing and maintaining a place for reading-rooms, library, and social meetings, and have complied with the provisions of the statutes of this Commonwealth in such case made and provided, as appears from the certificate of the proper officers of said corporation, duly approved by the Commissioner of Corporations, and recorded in this office:

Now, therefore, I, WILLIAM M. OLIN, Secretary of the Commonwealth of Massachusetts, do hereby certify that said JAMES H. BOWDITCH, D. BLAKELEY HOAR, ALLEN CHAMBERLAIN, JOSEPH S. NOWELL, WALTER C. WRIGHT, MYRON S. DUDLEY, WARREN H. MANNING, FREDERICK L. OLMSTED, JR., and JACOB U. PIERCE, their associates and successors, are legally organized and established as, and are hereby made an existing corporation under the name of the HASSACHUSETTS FORESTRY ASSOCIATION, with the powers, rights, and privileges, and subject to the limitations, duties and restriction which by law appertain thereto.

SEAL OF THE COMMONWEALTH

Witness my official signature hereunto subscribed, and the seal of the Commonwealth of Massachusetts, hereunto affixed, this third day of June in the year of our Lord one thousand eight hundred and ninety-eight.

WM. M. OLIN,
Secretary of the Commonwealth.

BY-LAW

ARTICLE I

The name of this corporation s
FORESTRY ASSOCIATION.

ARTICLE II.—PRIMAR

The purpose of the Associatio
methods in dealing with forests an
educate a public interest in this sub
station of unproductive lands; to
care of shade-trees; and to establis
reading-rooms, library, and social m

ARTICLE III.—MEM

There shall be four classes of
ever, that all members shall have e
no class shall enjoy any special pri
The classes of membership shall con
ing the sum of $1000 or more to the
sociation, or for any specified accept
shall exempt them from all future
Life Members paying a fee of $50, wh
permanent fund and shall secure exe
or assessments; (3) Contributing Me
nual fee of $5.00; (4) Annual Memb
be $2. All applicants for admission t
above-named classes shall comply wit
be imposed by the Executive Comm
shall be payable at the time of maki
ship, and thereafter on the first of
sons becoming members on or after
shall have their dues credited to the

Members in arrears for three y
the rolls by the secretary after not l
has been given to said members.

When valuable services have bee
forestry and circumstances in their j
the treasurer and secretary may at
dues of an annual member, *sub silen*

ARTICLE IV.—OFFICERS.

ers of this Association shall be elected by ballot at eeting of the Association and shall be: a President, elected each year and who shall be *ex officio* a e Executive Committee; a Vice-President from each Commonwealth except the counties of Barnstable, nd Dukes, and one Vice-President from one of those epresent all three, who shall be elected each year; who shall be elected each year and who shall be *ex of-*er of the Executive Committee; a Secretary who ted each year and shall be *ex officio* a member of e Committee; six members of the Executive Com-om two shall be elected each year for a term of three Trustees of the Permanent Fund of whom one ed each year for a term of three years; and Two whom one shall be elected each year for a term of

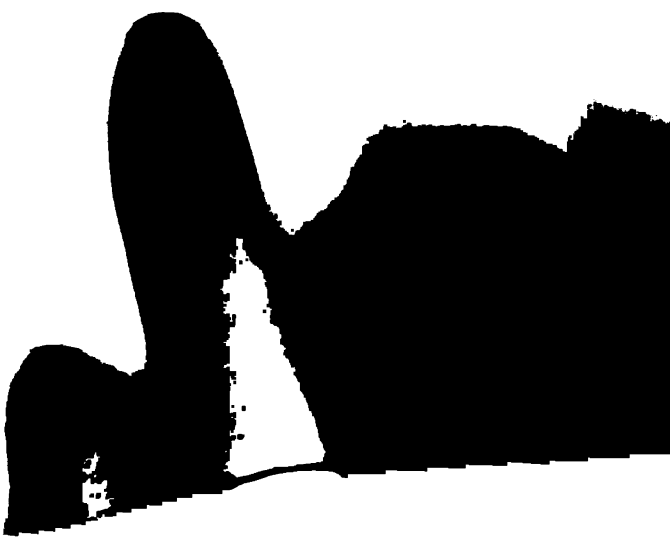
es of Secretary and Treasurer may be held by one officers shall be eligible for re-election.

ARTICLE V.—PRESIDENT.

ident shall preside at all meetings of the Associa-absence, the Vice-President for the county in which is held, or the Chairman of the Executive Com-e absence of the officers named a president *pro tem-*elected by the meeting.

ARTICLE VI.—TREASURER.

surer shall collect all dues, shall attend to all dis-hall keep the accounts of the Association and shall uested, at any meeting of the Executive Committee, f moneys on hand and the outstanding obligations tion, as far as practicable; and shall in the call for eeting report in print the receipts and disburse-previous fiscal year, which fiscal year shall end on t day of October. His book of accounts shall at all to the inspection of any member of the Executive Auditors. His accounts shall be audited by the east once in each fiscal year. He may be allowed sum for clerical assistance.



The Secretary, who
tion, shall give notice
Executive Committee, a
ings and of all matters o
able by the Association
duct the correspondence
all its documents. The
reasonable times be open
Association. He shall
keep a roll of the mem
Treasurer of the electi
keeper of the seal of the
such salary and sum f
Committee may determi

ARTICLE VI

The Executive Comm
management of the affa
instructions as may fro
sociation. It shall fill v
the next annual meetin
Chairman. The Executi
month except July and
other members of the Ex
Secretary shall call a sp
notice of the time and pl
bers of this committee s

The Executive Comm
as in its discretion it co
each sub-committee shal
mittee.

ARTICLE IX.—TRU

The Trustees of the
the Permanent and any
shall have power to ma
Trustees of the Perman
proceedings, and shall de
the Association's securiti
The Trustees of the Per
annual meeting, report i

ARTICLE X.—AUDITORS.

The Auditors shall audit the books and accounts of the Treasurer and of the Trustees of the Permanent Fund at least once a year and shall attach certificates of their findings to the annual reports of the Treasurer and of the Trustees.

ARTICLE XI.—ANNUAL MEETING.

The annual meeting of the Association shall be held each year, on the second Thursday of December, at the rooms of the Association in the city of Boston, or at such other time and place as may be determined by the Association or the Executive Committee.

A Nominating Committee of at least five members shall be appointed by the Executive Committee at its October meeting, whose duty it shall be to return, on or before the November meeting of the Executive Committee, a list of candidates for officers for the ensuing year. Said list shall be printed and mailed by the Secretary to all members of the Association, together with the call for the annual meeting. Every ten or more members desiring to make a nomination for office may, at any time five days previous to the annual meeting, send such nominations, signed by them, to the Secretary, and that officer shall provide printed ballots, or "stickers," for the same for use at the annual meeting. No person shall be a candidate for office unless nominated in accordance with the provisions of this article.

ARTICLE XII.—SPECIAL MEETINGS.

(*a*) Special meetings may be held at such times and places as the Executive Committee shall determine.

(*b*) A special meeting shall be called by the Secretary upon the presentation to that officer of a petition, in writing, for such special meeting, signed by at least ten members of the Association in good standing.

ARTICLE XIII.—NOTICES.

Fourteen days' previous notice of all meetings of this Association shall be sent to all members. The notice of each meeting shall state the business to be acted upon at such meeting.

ARTICLE XIV.—QUORUM.

Fifteen members shall constitute a quorum.

Five or mor
authority granted by the Execu
local work as a part of the Massachusetts
Such organization shall be known as a Br
town or district. There shall be a Pr
Treasurer and two other members elect
shall constitute the Executive Committ
offices of Secretary and Treasurer may
which case there shall be three other
Executive Committee, in place of two
direct the work of the Branch. Each B
in its territory and do such other work
to the approval of the Executive Com
The Secretary or Secretary-Treasurer
of all proceedings of the Executive Co
minutes shall be forwarded to the S
Members enrolled in branch organiz
to the Association as heretofore, bu
annually from the Treasurer of th
tion of a sum equal to twenty-five
enrolled in the Branch and paying
other sums shall be paid to it from
except upon special appropriation b
the Association.

Nothing in this Article shall
any way the rights and duties o
of the Association.

The Chairman of each Branc
the meetings of the Executive
without a vote.

ARTICLE XVI.—AFFI

At the discretion of the Ex
wishing to become affiliated w
paying the annual fee of $5.

ARTICLE XV

These By-Laws may be
of the members present at an
meeting duly called for this
such meeting shall contain a

TREASURER'S REPORT

For the Year Ending October 31, 1914.

Cash on hand November 1, 1913:		
General Fund	$1,070.20	
Appalachian Forest Fund	451.82	
		$1,522.02
Receipts.		
Annual Members	$3,832.00	
Club Members	130.00	
Contributing Members	1,825.00	
Life Members	550.00	
Gifts	4,269.50	
Income from Invested Funds	584.55	
Interest on Bank Balance, General Fund	32.15	
Rent	60.00	
Office Expense (Reimbursements)	9.69	
Sundry Expenses (Reimbursements)	7.50	
Branch Associations (Reimbursements)	16.00	
Stationery and Postage (Reimbursements)	6.50	
Printing (Reimbursements)	180.30	
Salary (Reimbursements)	40.00	
Profit and Loss	3.24	
		11,546.43
		$13,068.45
Expenditures.		
Salary	$6,808.09	
Rent	468.26	
Printing	1,400.50	
Postage and Stationery	1,486.34	
Traveling	235.64	
Office Expenses (Telephone, Light, Express, etc.)	237.33	
Sundry Expenses	622.31	
Office Furniture and Fixtures	12.50	
Membership Campaign	306.01	
Branch Associations	304.25	
Trustees Permanent Fund (Life Members)	550.00	
Advertising Campaign	150.00	
Profit and Loss	7.40	
Appalachian Forest Fund	29.30	
		12,612.53
Cash on hand October 31, 1914:		
General Fund	$33.40	
Appalachian Forest Fund	422.52	
		455.92
		$13,068.45

ERNEST B. DANE, Treasurer.

NOTE:—Gifts aggregating $1,000.00 having been received by the Association from Ernest B. Dane, he was duly made a patron member of the Association. In accord with the authority given the Executive Committee by the By-Laws this money was appropriated to the General Fund and is shown in the report of the Treasurer under the heading, gifts.

REPORT OF TRUST
FU

Schedule of Property in Han

American Ag. Chem. Co. prfd.
American Tel. & Tel. Co.
Boston Insurance Co.
Chicago Junct. Rwys. & Un. Stk. Y
prfd.
General Electric Co.
New York, New Haven & Hart. Rd
Pennsylvania Rd. (par $50)
Pullman Co.
American Tel. & Tel. Co. 4½s
Chicago Junct. Rwys. & Un. Stk. Yds.
Edison Elec. Ill. Co. L. A. 5s
Kansas Gas & Electric Co. 5s
Lake Shore Mich. So. Rd. 4s
New York Tel. Co. 4½s
Old Colony Street Ry. 4s
Western Tel. & Tel. Co. 5s
Cash on hand.....

SUM

Amount of property in hands of Tru
Received from Life Memberships..

PRINCIPAL ACCOUNT NOVEMB

1913

Nov. 1, Cash on hand uninvested.
1914
Jan. 1, Mrs. Augustus Hemenway,
Feb. 17, Eben S. Draper, life memb
Feb. 20, Robert M. Burnett, life me
Apr. 3, Charles H. Davis, life mem
Howard Marston, life mem
May 1, Caroline L. W. French, lif
May 15, Mrs. J. W. Sears, life mem
June 2, Miss Fanny Brooks, life m
June 10, Dudley P. Rogers, life mem
July 17, Frederick D. Southard, lif
Mrs. Alice M. White, life m

1914

Feb. 4, Edison Electric Ill. Co.
bought 1000 5s at $101.....
Oct. 31, Balance on hand.....

G
G
J

6

AUDITORS' REPORT

Boston, November 18, 1914.

We have examined the accounts of the Treasurer of the Massachusetts Forestry Association for the year November 1, 1913, to October 31, 1914, inclusive, and find them correctly cast and properly vouched, the balance on October 31, 1914, being $455.92.

We have also examined the accounts and securities of the Trustees of the Permanent Fund of the Massachusetts Forestry Association, and find the accounts correctly cast and duly vouched and the securities amounting to $18,508.92 as called for by the annual report of the Trustees.

JAMES NOWELL,
H. W. HIGHT,
Auditors.

To The Massachusetts Forestry Association:

Gentlemen:

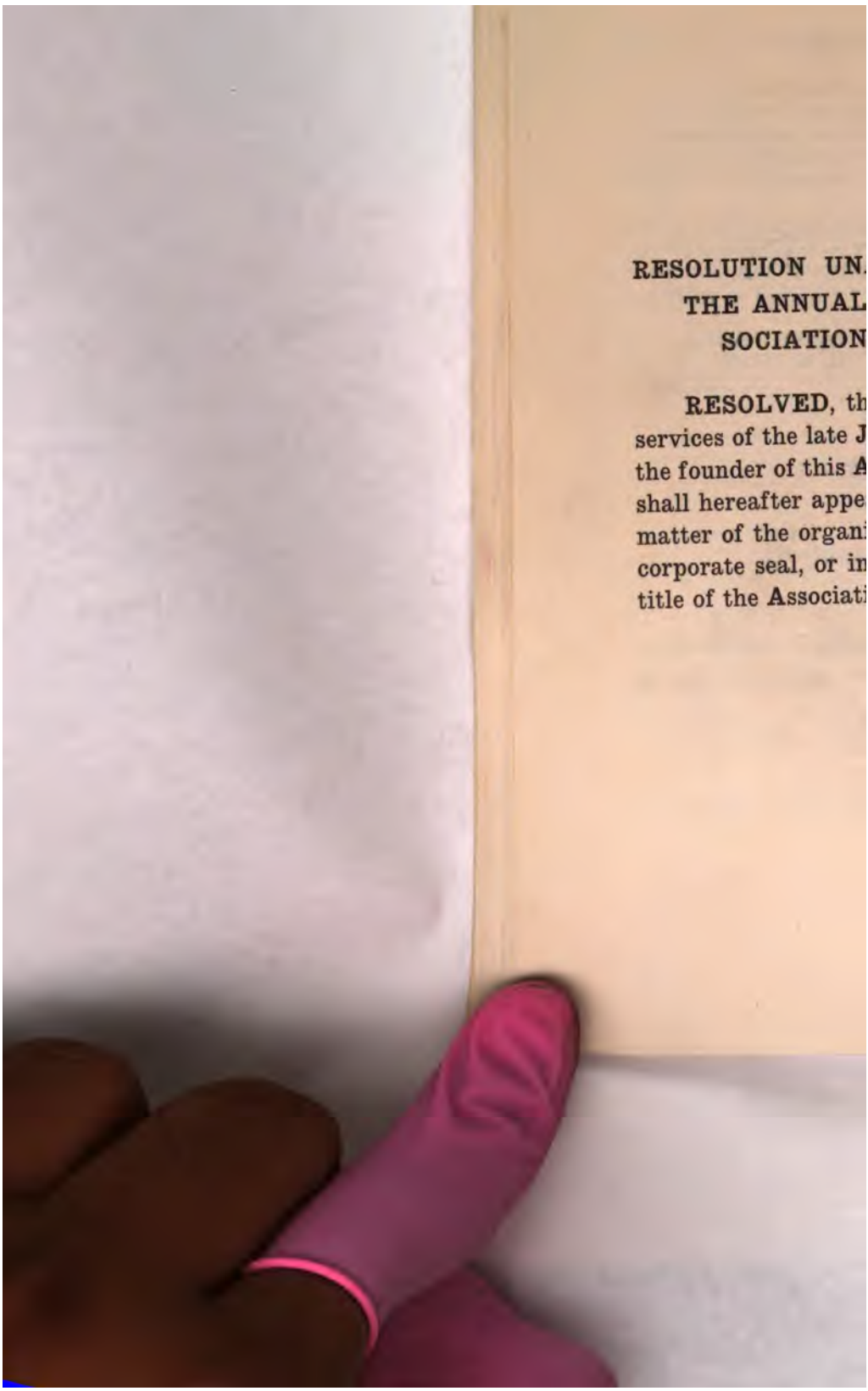
As a member of the Association, I wish to have my trees inspected by its forester for this district free of charge.

Location of estate.....

Approximate area of estate.....

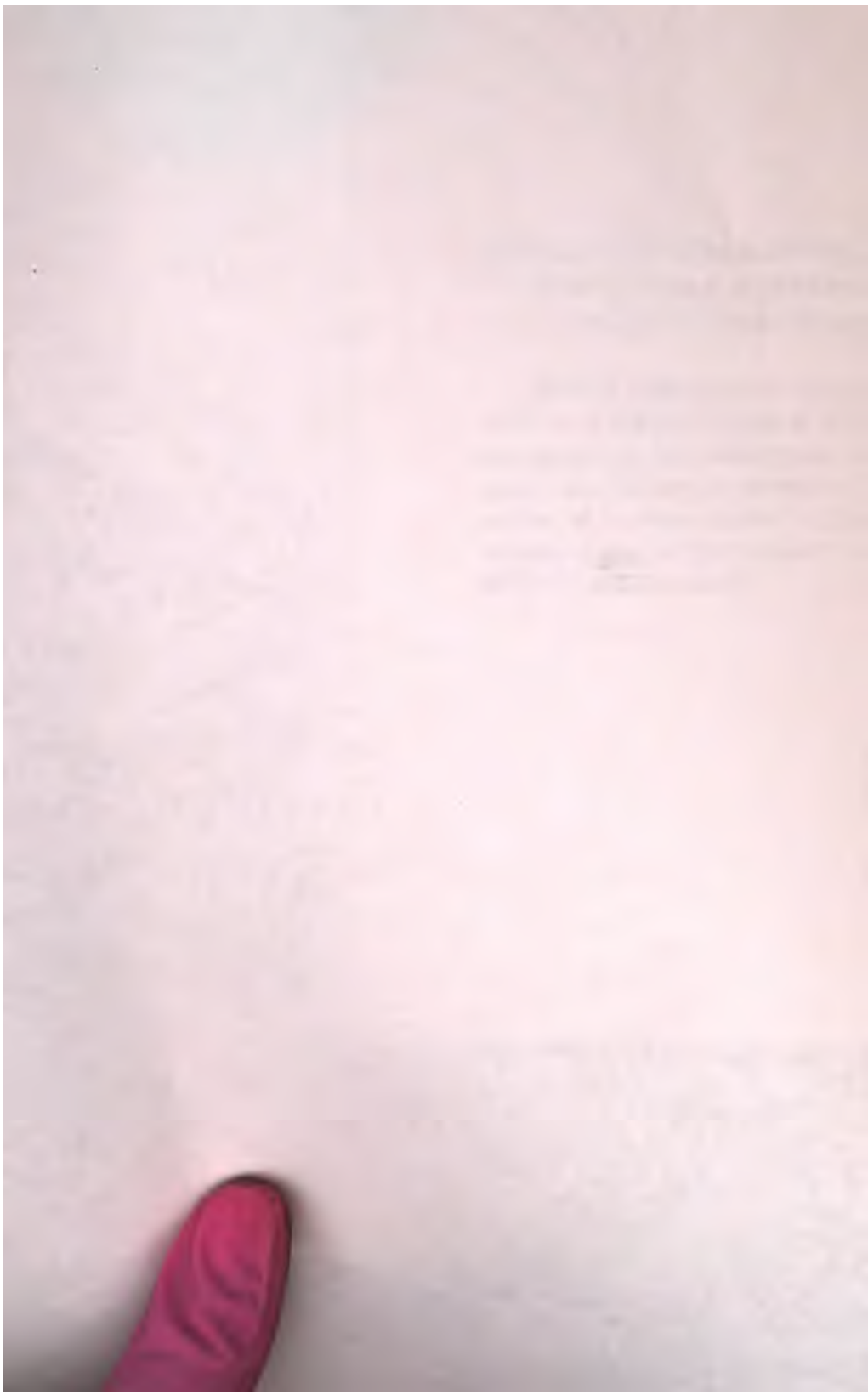
(Signed).....

.....191 (Address).....



RESOLUTION UN
THE ANNUAL
SOCIATION

RESOLVED, th
services of the late J
the founder of this A
shall hereafter appe
matter of the organi
corporate seal, or in
title of the Associati



MASSACHUSETTS AND HER FORESTS

FOR the past twenty-four years I have been employed as an official in educational, experimental, and demonstration forestry work in New England, having been State Forester of Massachusetts for the past thirteen years. During this time it has been my avowed purpose to do everything within mortal power to accomplish something in establishing fundamentals from which forestry practices of a permanent nature might be the outgrowth.

There are few, if any, problems of greater moment and more economic importance to New England at the present hour than that of forestry. There are those still living who have seen beautiful primeval forests dotting the hills and valleys everywhere throughout this rugged and beautiful country. Year by year these forests have succumbed to our mad rush of uneconomic commercialism, until today finds us in a sadly depleted and irrational condition.

THE FOREST PRIMEVAL

It is always easy to point out mistakes after they have happened; but experience, though a dear teacher, should sober us at the present time. Year by year the primeval forest has been cut and harvested. Second growth, inferior but valuable, has followed, where conditions have been favorable, which, in turn, has been utilized as soon as it reached merchantable size. Demand for forest products

has incr
tions as
cial pow
selves
During
fairly
forest
with
ness
W
as i
En
se
d
si
c

feet of rough lumber a year into finished products. When we realize that this is only a part of the product in one state, certainly not one-half of it, but only that portion which, after it leaves the sawmills, is further worked by machinery, it may give a basis for judging the industry. These wood-working industries are scattered everywhere throughout New England, and there are many thriving villages whose main livelihood is dependent upon them.

FORESTRY AND AGRICULTURE

Forestry and general agriculture in New England are to a great degree interdependable. While it is conceded that forestry is no longer a simple woodlot proposition, but one worthy of the economic utilization of all lands non-agricultural, nevertheless its development makes possible the use of labor and teams in winter at a time when they are available. Large forest areas in various sections will greatly augment, therefore, both manufacturing and agriculture.

We have not begun to realize even yet what we should in the economic utilization of the forest products we still possess. It was not until we were freezing, due to the coal shortage following war conditions, that we realized that wood has a value for fuel. Our fathers depended upon it altogether.

In recent years wood has gone out of style, and even farmers have found it more convenient to have coal shipped in from Pennsylvania and West Virginia than to cut it on their own farms. It is an actual fact that during the trying times a few years since, the winter of the unemployed, there were instances

of people practically freezin
wood in great quantities was
on our hillsides.

War conditions drove our
wood in their furnaces and
is believed many will conti
firewood than heretofore as
vantages even over coal. C
a by-product of the forest.
of wood for fuel should be a
est sections, as it is to the be
that improvement thinning
and whenever forest crops ar
there are always the limbs,
suitable for little else than
great hindrance to the use o
the past has been the inco
which it has been dealt.

City people, and users in
lighted to purchase wood cu
short sizes. They do not
lengths. Every conceivable
be used if cut into small siz
we not be able to utilize ev
possible for fuel in our more
sections of New England?
there should be more definite
it into charcoal, or shipping
ries, or using it in other w
pressed in this respect when
est country abroad. Everyt
ized, and there is no waste.

NEW ENGLAND FOREST

Each of the New Englan
forest policies, and is feelin
greater accomplishments.
been done than most people

chusetts, for example, has enacted laws aiding forestry in the following ways:

1. Expert advice at no expense, except travel and subsistence, to anybody in the Bay State.

2. Free forestry literature, to be sent to all citizens who care to make use of it.

3. Forest-fire prevention. — A forest warden in each town, with equipment, organization, and mandatory laws, to get results.

4. There are thirty-five forest-fire lookout stations scattered over the State on high points, which are connected by telephone with local and State officials to bring aid.

5. Forest Warden Conventions. — The forestry officials of cities, towns, and the State are empowered to meet to discuss methods, equipment, and better ways of co-operation.

6. State Aid for Forest Fire Equipment. — The poorer towns are given State aid in procuring equipment.

7. Utilization of Forest Products. — Studies and practices of making greater economic use of all wood in the industries, and for fuel. This includes the cost of production and transportation.

8. Regulations of brush and slash disposal.

9. Railroad fires and railroads.

10. Forest Taxation. — A modern system of taxing forest lands and their production.

12. The acquiring of lands for State Forests.

13. State Forest Nurseries. — Young trees are grown in State nurseries for use on State lands, and are sold at cost to citizens and municipalities.

14. The Governor has power to issue proclamations for a closed season on hunting in dry times.

15. Reforesting Private Lands. — Lands suitable for planting may be turned over to the State Forester by title, with power of redemption within ten years, provided the expense of planting and care is reimbursed to the State.

16. We have probably pla
setts, in both public and p
25,000 acres.

WEEDING OUT NEEDE

Do not think that planti
is the whole thing. Much
est lands need weeding ou
rational management as we
datory laws that have eno
so that uneconomic practi
lowed even on private ho
seem a strong policy, but
are their own worst enem
the economic use of lands
made a success only when
individual also, in a larger
community.

England begins at once to
in forestry. Are we of Nev
ing under anything like the
cial and otherwise, that al
ing? Should we not at leas
start?

If our farmers are afraid
in congress will create over-
culture, why not convert a
share into improving our f
throughout New England?

FUTURE WHAT WE MA

The future of New Engla
exactly what we of today p
We can continue to go alo
pace and try to feel we are
but what is really needed
business-like and more dras
to really accomplish result

live business principles, backed up by modern financing. If, as Americans, we can build a Panama Canal, a Roosevelt Dam to irrigate the desert, and spend uncounted billions to better the world's conditions, surely the raising of funds sufficient to finance an undertaking bound to solve the future successful existence of a country whose traditions are dear to us is nothing for Americans to undertake.

It matters not, either, whether the individual or the State does the work. The main thing is to get it done. Private forestry needs to be greatly encouraged, but it is believed that the State and Nation should shoulder the undertaking. Where would the Allies have turned had not France, to the credit of her statesmen and people, in earlier time begun the practice of forestry?

We need in New England to begin not tomorrow, but today, while we still have some remnants to tide us over the lean period, to go to work on a tremendous scale to recoup our birthright. It takes time to grow a forest, but we have the possibilities in millions of acres of idle lands that will work for us day and night, winter and summer, constantly solving the basal economic problem of the future of our Pilgrim lands, if only we do our duty by them.

It is the time for all men of affairs throughout New England to give this subject constructive thought. The future of New England Forestry will be what we of today make it in guiding its destiny.

State House, Boston, Mass.
Sept. 15, 1919.

Town Forests

Premium Plantings

FITCHBURG'S TOWN FOREST

This is said to be the first legally established town forest in the United States. White pine about forty years old

MASSACHUSETTS FORESTRY ASSOCIATION,

4 Joy Street, Boston, Mass.

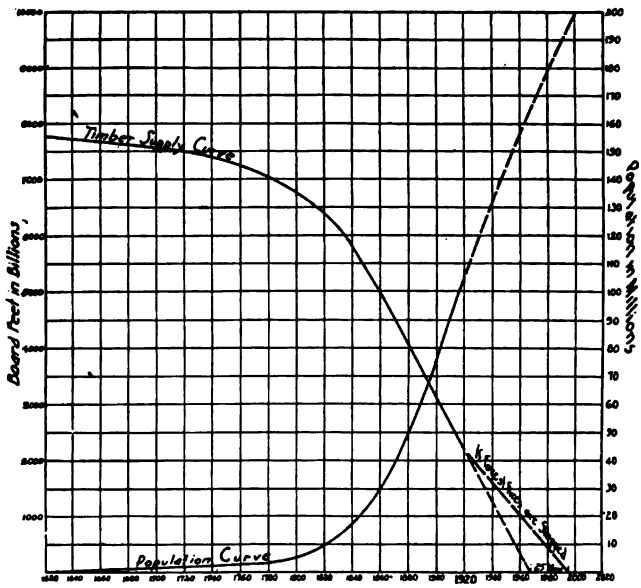
AGRIC. DEPT

WHY MASSACHUSETTS NEEDS TOWN FORESTS

Some Facts to Be Faced

1. Of the forty-eight States, thirty-three consume vastly more than they produce, and Massachusetts is one of them. About five-sixths of the original timber in this country is gone, and according to the best available information the supply will be exhausted in fifty years. One hundred years ago we had 10,000,000 people and over 6000 billion board feet of timber. Today we are starting on another century with over ten times as many people and less than one-third as much timber.

Our Vanishing Timber Supply



POPULATION CURVE MADE FROM U.S. CENSUS REPORTS
Timber Supply and Forest Fire Data from the Capper Report Compiled by the U.S. Forest Service, and other Sources

2. Massachusetts now imports about eighty per cent of the wood it uses, while within the memory of men still living she was one of the large timber exporting States. In other words, the lumber used in four out of every five houses we build today comes from other States, mainly from the South and the Pacific Coast, and the high cost of lumber is reflected in higher rents.

3. Foresters and lumbermen are agreed that within twenty years the bulk of our lumber will have to be brought from the Pacific Coast, and the cost for transportation alone from there is more than it would cost to grow the timber here at home.

4. Why should we pay the people of Oregon or Washington to cut and saw our lumber and then pay the railroads or steamship owners to haul it to us, when we have over 1,000,000 acres right here in Massachusetts which will grow much of the timber we need if it is set to work?

5. So far as we are concerned a fifth of this State might just as well be a desert as in its present condition. It yields about ten cents an acre on the average yearly in taxes, and nothing for the owner. It costs more to protect it than the income from it in taxes. Planted to trees of commercial species, and managed on forestry principles, this land will yield about $5.00 per acre per year (not realized of course until the crop is harvested or the land sold) besides creating an industry when the first crop is produced, which will furnish permanent work for 20,000 men.

6. Forest fires are sweeping over 10,000,000 acres—an area twice the size of Massachusetts—annually, in this country, causing a loss of over $20,000,000 in standing timber and as much more in soil, humus and young growth.

7. Imported and native insects and fungi are also destroying millions of dollars in timber annually, and at the same time increasing the risk and cost of producing timber.

8. It requires from fifty to one hundred years to grow a crop of timber—depending on the species—and for that reason reforestation is not an attractive investment to the average individual. He must not only run the risk of losing his initial investment, interest and taxes, from fire, insects, disease or other causes, but he can hardly hope to reap the profits unless he can realize on the sale of the land and the growing crop.

9. As a nation we are facing our first serious problem, created by the shortage of a natural resource, and it must be solved and solved comparatively quickly if our children and grandchildren are to enjoy the conveniences and comforts which we have derived from an abundant supply of timber. A bountiful timber supply has been one of the most important factors in our wonderful industrial development. WE HAVE REAPED WHERE WE DID NOT SOW. But, we have reached the turning point, and must now follow the course of older nations who have been forced to grow their timber instead of finding it ready to cut, as we have done for the past three hundred years.

10. All countries faced with a timber shortage in the past have found that the production of the forests is a function of government. It is a public duty to supply a public need which cannot be supplied by private initiative. Timber must be had to supply our industries Therefore, if it is not produced by the individual, it must be produced by the public, even at a financial loss on the production operations. Our wood supply in the future must come largely from National, State, County and Municipal Forests. In Massachusetts the town is the political unit which must play the most important rôle in the production of our future timber supply.

502422

TOWN FORESTS IN EUROPE

The idea of towns owning commercial forests is not new. Some such forests in Europe are several hundred years old, and the best proof of their success is the fact that the cities and towns are still buying more forest lands for that purpose. Cities and towns in practically every country of Europe own town forests.

That these forests are profitable to the towns can best be shown by a few examples. The average annual net profit per acre for ten of such forests visited by the writer before the war in Switzerland and Germany was $6.20. In practically every case the land was too steep or otherwise unfit for agriculture, except for small patches within the forests that were tilled by the peasants.

The town forest of Forbach in the Black Forest region is one of the best examples, with an annual net profit of $12.14 per acre. The forest covers an area of 1482 acres and the population of the town was 1900 at that time, which was in 1913. In many places certain citizens whose ancestors helped to establish the forest received each year a part of the profits, and in other places they received free firewood. A number of citizens in Forbach received $36.00 each, annually, from the profits obtained from the town forest. The people of many of the small villages which own large forests had no taxes to pay. IMAGINE BEING HANDED A CHECK INSTEAD OF A TAX BILL!

TOWN FOREST OF BADEN-BADEN IN THE BLACK FOREST SHOWING METHOD OF TAKING OUT THE TIMBER

The city of Zurich, Switzerland, has a very famous forest, known as the Sihlwald. The topography is mountainous, and the forest is very expensive to maintain, but even with the establishment of old-age pensions, accident and sickness insurance for employees, the forest still nets from $6.00 to $7.20 an acre yearly. It is one of the most highly developed forests in Europe, being about 1000 years old, and the cutting rotation for all species is 110 years. The forest gives permanent employment to one man for every thirty-three acres and many temporary employees are added to the force in winter and during seasons of unemployment.

It is interesting to note that the prices paid for bare land for town forests ranged from $50.00 to $80.00 per acre, and where the land contained forest growth the price varied from $120.00 to $240.00 per acre. It is evident that those cities and towns receive more benefits from their town forests than the money profits. In the small outlying places wood-using industries are located which are dependent upon the products of the forests. The small farmers practise intensive farming on their patches of land in the summer and go into the town forest as laborers in the winter. All the old-established forests are on a sustained yield basis so that they know just how much timber they can cut yearly for an indefinite period. This fact tends to stabilize the small industries, which can always count on a steady and permanent supply of raw material.

While we cannot make comparisons between this country and Europe generally, because of different standards of labor and of living, it would seem that if the cities and towns of the European countries can afford to pay $80.00 per acre for bare land for town forests, we would not be making a mistake here to buy lands for a similar purpose at $5.00 an acre, the amount at which much of our idle land is assessed.

The town forest of Europe really fills the place of our wild parks in this country. But, the difference lies in the fact that they practise forestry on such lands and make them pay for their maintenance besides returning a money profit. With us such areas have to be supported by taxation. The people go into the town forests by the hundreds on Sundays and holidays. Small inns are established in the beauty spots where their favorite refreshments are to be had in abundance. Game, especially deer, is plentiful. The hunting seasons are very short and the licenses expensive. Bird sanctuaries are maintained.

The town forest is free from local politics. Usually the State appoints the forester, whose decisions as to methods of management are final. He is paid by the town and is one of the leading citizens. The town forest is one of the most popular local institutions in Europe.

TOWN FORESTS AT HOME

Fitchburg holds the unchallenged distinction, so far as we know, of having established under a State law the first town forest in the United States. It is composed of four parcels, the smallest being ten acres in area, the largest forty-seven acres. The aggregate area is one hundred and nine acres. This forest was created on December 29, 1914.

About half of the land is covered with natural growth, both hardwood and pine. The natural growth pine is approaching maturity as the picture on the front cover shows. The remainder of the area is being planted to pines and the whole tract is being handled in an efficient manner by the city forester.

One thing to note about the Fitchburg forest is that it is not all in one tract, which shows that very small areas can be obtained for this purpose and still be profitably managed. In fact, a distribution of the areas reduces the fire risk.

The town of Walpole is the second place in the Commonwealth to secure a town forest. It was very fortunate in having a public-spirited citizen who presented it with one hundred and fifty acres of land near the official center of the town. Forty acres were planted in one year. The school children planted the first acre on Arbor Day, 1916, and the pines planted by them are shown in the foreground of the picture below. The forest has also been made a bird preserve. Fire prevention has been an important feature of the work already done and with the construction of roads and other facilities it is destined to be one of the finest recreation areas in the State. The splendid example set by Walpole should be an inspiration to other towns.

Brookline has a watershed of three hundred and fifty acres, which is known as its town forest. The town has planted several thousand pines and the area will some day be covered with a valuable forest. There is no reason why the watersheds of cities and towns should not be producing commercial forests which, when mature, can be cut conservatively without contamination to the water supply or injury to the forest floor. One purpose of the Town Forest Act is to encourage such treatment of the watersheds of cities and towns, and in fact many places are already making progress in covering those areas with growth of commercial value.

Second growth white pine about fifty years old in the Petersham Town Forest. This land was farmed just before the Civil War.

Petersham, like many other towns, owned a Poor Farm. It contained about two hundred acres and most of it was covered with forests in various stages of development. Some twenty years ago the almshouse was closed, but the farm still remained town property. Little attention was given to it until some one proposed that the farm be sold. Then a committee was appointed and instructed to investigate the matter.

That committee found the greater part of the farm covered with splendid stands of white pine, some of it merchantable, and that an increment of not less than seventy-five thousand board feet was accruing each year. The committee therefore recommended that the property be held as a town forest and that a sale of timber be made immediately. The town meeting voted to instruct the selectmen to carry out the recommendations of the committee's report. Accordingly, an area of about thirteen acres was marked off and the timber sold at auction for $5200, or $400 an acre. "While this sum is at least a third of what the whole property might bring today, it is hardly a tenth of the total returns which may be got from the forest during the next forty years" in the judgment of Director Richard T. Fisher of the Harvard Forest and a member of the committee.

THERE ARE NINETY OTHER TOWNS IN MASSACHUSETTS WHICH OWN POOR FARMS, EACH CONTAINING OVER TWENTY-FIVE ACRES OF FOREST LAND, WITH AN AVERAGE OF EIGHTY-NINE ACRES. EVERY ONE OF THESE TOWNS COULD PROFITABLY FOLLOW THE EXAMPLE OF PETERSHAM.

TOWN FORESTS AND FARMING

One hundred and thirty-eight towns in Massachusetts have fewer inhabitants today than they had fifty years ago, and on the average the loss has been twenty-five per cent. Although the population of the State as a whole is two and one-half times as great as it was in 1870, the fact remains that besides this large proportion of towns that has actually lost in population, a large number of others have little more than held their own.

The causes for this exodus from the small outlying towns are many, but the time they were most prosperous was when they were still well supplied with timber, which kept the sawmills and wood-working establishments going. These industries held many people in the towns and created a ready market for farm produce. With the disappearance of the timber the sawmills abandoned the towns, as did many of the small wood-working establishments, and this reduction in population was an important factor in bringing about the abandonment of farms.

It is acknowledged even by the leading agriculturalists that many of these abandoned farms cannot be utilized profitably for the growing of crops and it therefore would seem that the best possible use for them is the production of timber.

Town Forests Established on the Idle Lands Not Suited for Agriculture Would Benefit the Farmer.

1. The idle land in any town which is generally listed as sprout or brush land is of little value to the owner, produces but a few cents per acre in taxes and does not furnish employment to anyone. If this land was taken over by the town and the weed trees replaced with trees of commercial species, like white pine, the land would furnish employment to some persons almost from the beginning in preparing it for planting and in doing the planting. Much of this work would be done either in the winter or at mud time on the farm, and would furnish employment to the farmers and farm laborers.

2. After the young trees were planted there would be work in the building of roads and fire lines and after a few years the thinning of the plantations would begin. When the trees neared maturity, if the forest was properly managed, there would be some work every year for men and teams. This would enable the farmers to employ their teams, which would otherwise be idle in winter, and to find work for their farm hands.

3. While the land devoted to town forests would be taken out of taxation the loss would hardly be noticeable, and once it was set to growing trees, it would be producing lumber, the net profit from which when harvested would average about $5.00 per acre per year, which would help reduce the tax rate.

4. If the supervision and general management of the town forest was placed under the State Forester, as it should be in most cases, the farmers would benefit by having increased fire protection to their own wood lots, because when money is once invested, either by the State or the town in the growing of trees, more attention is given by the public to fire prevention and other protective measures. Furthermore, the representative of the State Forester would be constantly available to advise the farmers in the treatment of their own wood lots.

5. In many of our towns there are today small wood-using industries which are having difficulty in obtaining raw material locally. The production of timber in town forests would help to retain those industries and even bring more into the town, which in turn would increase the population and enlarge the market for the farmers' produce.

6. Increase in population, which is today the big problem for the small town, would mean a general increase in the value of real estate, and in this the farmer would participate as well as the villager.

7. While the scarcity of timber will affect the Massachusetts farmer less than the city or town dweller, nevertheless, many things made of wood for use on the farm cannot be made by the farmer from his own wood lot, and much of the timber used today in tools and in the building of dwellings comes from other States. If we were to produce forests on all of our now idle lands, it would greatly reduce the cost of lumber which in a greater and greater degree is now being brought from the Pacific Coast.

ABANDONED FARM

Hundreds of farm buildings like this have been abandoned in Massachusetts. Orchards, fences and other farm facilities have gone to ruin. Some of these farms may be reclaimed, but most of them are fit only for tree growth and should be used for town forests.

TOWN FORESTS AND LOCAL INDUSTRIES

The days of the tramp sawmill in Massachusetts are numbered. Some of them are already having a hard existence. The lots cut over are smaller, the moves more frequent and the distances greater. Transportation of logs by trucks enables the stationary mill to serve efficiently a much larger territory than ever before. The cost of moving is eliminated, the machinery can be properly housed, the maintenance is less expensive and the employees are more permanent.

In fact, there are many examples in the State where the permanent sawmill or wood-using factory has been located in one place for generations. Those mills have practically reached a capacity where the output equals the annual growth in the district served. When this condition becomes general, we can then practise forestry on a business basis which will insure a local supply of raw material to keep those home industries going. Instead of floating organizations coming into a town and cutting a lot here and there often with outside help, this work will be done by the people who make their homes in the towns.

The sooner we can reach that condition generally, the better it will be for our towns. It will mean more permanent residents in the small places and the result will be beneficial to every kind of business located there. It is simply a problem of making the natural resources of the community support the maximum number of families, and the creation of town forests will be a long step toward accomplishing that result.

KEEP THIS INDUSTRY GOING WITH HOME-GROWN TIMBER

PLANTING YOUNG PINES ON THE MYLES STANDISH STATE FOREST—PLYMOUTH COUNTY

Thousands of acres of idle land like this are to be found in Massachusetts. Every town should reclaim the idle land within its own boundaries by the creation of town forests.

Town Forests and Unemployment

In times of unemployment, ways and means are sought by which persons who must have work may be assisted by the public, and at the same time have their labor serve a useful purpose. Unemployment is primarily a local problem. When a man is broke he cannot afford to travel far in search of employment. Winter is the most serious period for the unemployed, because his wants are greater and many kinds of work cannot be done in cold weather.

While unemployment in the small towns is not so common as in the larger centers, yet there are many towns and cities where idle land is available and where unemployment is a common thing. In such places the town forest is a good outlet for such surplus labor. Logging, thinning, building of fire lines, roads and other facilities can be done in the winter almost as well as at other times. Therefore, the town forest can be developed at such times and work can be done then that might otherwise be delayed.

There are many areas now classed as idle land where young trees like the White Pine are struggling in competition with worthless species, and to cut out these weed trees would be equivalent to the planting of the pines that are now there. If left untouched, however, these seedling trees must succumb and give way to their more thrifty but worthless neighbors. The cutting out of these weed trees can be done in the winter,

TOWN FORESTS AND RECREATION

The tension of our modern civilization calls for wholesome recreation and no city or town is wise which does not provide amply for play in the open. A wild park has more attractions to the young than the neatly kept public garden cluttered with "keep-off-the-grass" signs. The picture below was taken in a National Forest in the West, where a very large per cent of the population spend their vacations camping, fishing and tramping through the forests. A town forest makes an ideal place for picnics and camping parties and in these days of "no trespass" signs such areas give an opportunity to the boy and girl scouts to enjoy the freedom of the forest near at hand.

The custom of going camping with an automobile is fast becoming a habit with many people here in New England just as it is in the West. It is a splendid custom, but the public must recognize the need of providing camp grounds for this purpose. Not everybody uses the same manners on such excursions as he does at home, and this explains the disfigurement of many of the beauty spots along our highways. Public camp grounds for automobile parties should be provided by every municipality just as is being done throughout the West and in some sections in the East. This would bring the most of those people together, where some supervision could be maintained. Such camp grounds more than pay for themselves in the trade brought to the town, the protection against forest fires, and in the cleanliness of the roadsides.

In the town forests, such camps can be easily and cheaply established and, in fact, the two ideas are so closely related that they should be considered together.

RECREATION LIKE THIS IS GOOD HEALTH INSURANCE

TOWN FORESTS AND THE CONSERVATION OF WATER

We have very few mountains or bare steep slopes in Massachusetts and we do not want any. However, it has been proved even in this State that the cutting of the forests at the headwaters of our small streams affected them adversely. We cannot afford to waste our water because it is one of our chief sources of power. One-seventh of the motive force of Massachusetts comes from falling water and much of our water power is still unutilized.

The forest is the greatest of all natural reservoirs, and we owe it to ourselves and the industries which are dependent largely upon water power, which employ hundreds of thousands of our citizens, to keep our streams protected with forests on the watersheds. One town forest may not have much influence on the water supply, but in the aggregate, if the towns and cities will reforest their idle lands, several hundred thousand acres will be covered with permanent forests.

THE BROOK

I steal by lawns and grassy plots, I slide by hazel covers;
I move the sweet forget-me-nots, that grow for happy lovers.
And out again I curve and flow, to join the brimming river,
For men may come and men may go, but I go on forever.

—*Tennyson.*

What He Might Have Written Had He Seen This Brook

The forest once my source is gone, I raze the hazel covers;
I sweep the dwellings from my banks, once filled with happy lovers.
And now and then I rave and roar, just like a brimming river,
For though I still may come and go, I'll soon be gone forever.

WAYS AND MEANS OF CREATING A TOWN FOREST

Some Suggestions as to How to Go About It

1. Have a committee of representative citizens investigate the possibilities of the town for town forests and put an article in the town warrant, providing an appropriation for the purchase of the lands recommended by the committee, or authorizing the sale of bonds for the purpose.

2. Have an organization like the Chamber of Commerce, the Women's Club, the Village Improvement Association, the Boy Scouts and Girl Scouts or any other civic organizations take the lead or co-operate in presenting the matter to the voters at the town meeting.

3. Have any one or a group of the organizations raise the money for acquisition by public subscription, buy the land and present it to the town for a town forest.

4. Have the water supply area converted into a town forest.

5. Make the forest land of the Poor Farm into a town forest.

6. Have the committee solicit gifts of land for the purpose.

7. Have any unused public land fit for growing timber converted into a town forest.

8. Extend the present parks by adding land for town forests.

9. Urge some individuals to make a gift of a memorial forest.

10. Create a forest as a memorial to the soldiers of the town who lost their lives in the Great War.

11. As a means of raising money ask individuals and business firms to subscribe enough money to pay for one or more acres of the land to be bought.

12. Do not overlook the argument that the State will furnish young trees as soon as they are available, free of charge, for the planting of the forest.

13. Remember also that the management of the town forest can be turned over to the State Forester and in that way the town will receive technical advice free of charge.

14. An inspection of the assessors' books will enable you to locate readily the possible areas that are fitted for town forests. The assessors will no doubt be able and willing to furnish information about any specific tracts.

15. The State Forester is available to give you technical advice as to the fitness of any tract or tracts for town forests.

16. The offer of the Massachusetts Forestry Association to plant 5000 trees in the town forest should be of assistance in arousing interest. It will insure a beginning in the creation of a profitable forest.

SUMMARY OF THE LAWS PERTAINING TO TOWN FORESTS OR PUBLIC DOMAIN

By Chapter 45, Sections 19 to 24 inclusive, of the General Laws, a town may by a two-thirds vote at an annual meeting, and a city by a two-thirds vote of the council, determine to take or purchase lands for the culture of forest trees. Land held for water supply purposes in other cities or towns may also be converted into public domain.

The town forest may be placed under the supervision of the State Forester, who shall make regulations for the care and use of such land. Buildings may be erected on the town forest for public instruction and recreation, and these may be leased by the city or town.

All sums derived from rents or from the sale of the products from the town forest shall be applied so far as may be necessary to the management thereof.

No expenditures shall be authorized until the appropriation therefor is provided.

Under Chapter 44, Section 7 and Section 10 of the General Laws, cities and towns may incur debt within the legal limits for the acquisition of public domain.

Chapter 132, Section 35, of the General Laws, provides that cities and towns may acquire by purchase, gift or bequest, lands for reforestation at a rate not exceeding $5.00 per acre, and that the Department of Conservation may furnish seedlings for

Courtesy of Massachusetts Department of Conservation.

LET US GIVE THESE BABY TREES A CHANCE TO GROW LIKE THE ONES SHOWN ON THE FRONT COVER

FIVE THOUSAND TREES TO BE PLANTED AS A PREMIUM

The Massachusetts Forestry Association offers as a premium to plant five thousand trees, or approximately five acres, free of charge for any city or town which will legally establish a town forest of one hundred acres or more in area during the calendar year 1922. The trees will be planted as soon after the establishment of the forest as practicable, and it is understood that the city or town will put the land in proper condition for planting and that it will agree to give the trees reasonable care and protection after they are planted.

HARRIS A. REYNOLDS, *Secretary.*

October, 1921.

The State transplant nursery at Bridgewater.

Public Document No. 73

THE STATE FORESTER OF MASSACHUSETTS

SIXTEENTH ANNUAL REPORT 1919

F. W. RANE, State Forester

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1920

The State transplant nursery at Bridgewater.

Public Document No. 73

THE STATE FORESTER OF MASSACHUSETTS

SIXTEENTH ANNUAL REPORT 1919

F. W. RANE, State Forester

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1920

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

CONTENTS.

	PAGE
Organization,	11
State forests,	12
State plantations,	14
Nursery work,	16
Blister-rust work,	18
Examinations,	19
Tree planting,	20
Gypsy-moth spraying,	21
Moth thinnings,	23
Cranberry-bog work,	25
State Fire Warden's report,	26
Lectures and addresses,	35
State highway work,	35
Distribution of supplies,	36
Financial statements,	38
Financial summary of moth work,	43
List of forest wardens and local moth superintendents,	51
Summary of recommendations,	61

The Commonwealth of Massachusetts

SIXTEENTH ANNUAL REPORT OF THE STATE FORESTER.

To the General Court.

I take pleasure in submitting herewith a brief outline of the activities of the State Forester for the past year, together with the organization and data that should be definitely recorded.

While we feel that the public have been aware of the strenuous activities of the State Forester and his broad field of work in past years, which has included, besides perfecting a State forest policy for Massachusetts, the gypsy and brown-tail moth suppression, aggregating the supervision of an expenditure of a million dollars a year, and other important work assigned from time to time, such as handling the unemployed, etc., it still remains for the writer to say that these times are incomparable with the complications that have developed during the past year.

When an organization is running well and its policies are clearly defined and understood, there is little trouble meeting all ordinary emergencies. When, however, such calamities as war conditions break in upon a department like this, and fairly strip it of labor, both skilled and ordinary, and materials of all kinds advance in price while appropriations remain the same, or are made less, it inevitably follows that a department is powerless to do aught else than adapt itself to the new conditions.

In submitting this, the sixteenth report of this department, and the fourteenth report of the writer, I am citing the above simply to call to mind conditions that a State official charged with the responsibilities of State Forester in Massachusetts has had to contend with.

It is not my desire, however, to strike any note of pessimism in this report, for, regardless of the war clouds and the resultant disadvantages and inconveniences, we have, like all typical Americans, risen to the emergency and found ways of solving our problems.

The activities of the year have been exceedingly numerous. While the possibility of covering our broad field of work the first part of the year was doubtful, as the season advanced we found new means, so I can frankly say that the year as a whole has been well rounded out, and it is with a degree of pride for our accomplishments that this report is submitted.

Almost immediately following the signing of the armistice there was a wave of increasing interest in forestry matters. We believe the object lessons that our soldiers gained from the forestry standpoint while abroad will help in molding the future in forestry work in our own country.

The important part that forest products played in winning the war is well recognized at the present time. As each shipload has returned, just so many men have sung the praises of the French forests, and their great economic importance to the Allies in the world struggle.

Although staggering under a most burdensome debt, England has already enacted legislation setting aside millions of dollars for reforestation and other forestry work. We predict a greater interest in forestry from now on, particularly here in New England, where it is greatly needed.

The giving of free advice and the making of examinations of forest tracts by the State Forester and his assistants has been continued, though not as much as in pre-war times. The high price of labor and the inability to get experienced woodsmen were natural handicaps. With the relatively high prices of forest products, however, there was an inclination on the part of many to operate.

The administration of the five newly acquired State forests demanded considerable attention. The financing of this work was somewhat complicated, as there was no definite appropriation for carrying it on by the department, and funds were made available through the courtesy of the State Forest Commission.

Reforestation work to the extent of practically 1,000 acres,

in which 845,000 transplants were set out permanently on these State forests, was carried on last spring. There were 740,000 seedlings transplanted from our State nurseries into newly made nursery beds on these same forests for future use.

It is our plan to center more of our activities in general forestry undertakings upon these forests in the future, so as to have an interest develop here that would radiate throughout the section. These forests are fortunately well scattered over the State, and may be made to serve the purpose of good object-lessons in all kinds of forestry methods. Three of these forests have already permanent caretakers who live on them throughout the year. Some of the forests are beginning to be sought after as vacation and recreation grounds. The Myles Standish Forest, in particular, which has a number of beautiful lakes in it, is being laid out into camping and bungalow sites. Already nearly one hundred of these have been taken, and we have a large list of applicants on our waiting list.

The general care of these forests is vested in this department, and signed permits covering the regulations are executed in each case.

Forest fire equipment, patrols, lookouts and fish and game regulations on these State forests have also been made to conform to definite regulations.

Our three State nurseries at Amherst, Barnstable and Bridgewater have all been producing to full capacity excellent stock, which has been a great asset in our State work. Besides the trees given to the State forests, 255,000 were used in our co-operative reforestation work, there being a total of 165 lots that have been turned over to the State for planting in accordance with the reforestation law. Several lots which were earlier turned over in this way have been redeemed by the owners during the year.

We sold outright to private owners during the year 467,000 small trees; also a large number of trees from these nurseries were given to various State institutions free of charge.

The greatest drawback in nursery work was caused by the inability to secure tree seeds. While we were fortunate in getting our orders placed early, and in securing a large part of them, it developed later that evergreen seeds were not to be had

at any price. This same condition is likely to prevail the coming season; however, we have assurances from seedsmen abroad that a portion of our supply is secured to us.

Through a co-operative arrangement with the Massachusetts Department of Agriculture and the United States Department of Agriculture a contract was entered into whereby all of the plantations that were set with imported white pine stock in 1909 were gone over and all wild currant and gooseberry were removed. A detailed report of this work is to be found elsewhere.

During the past year we have completed our State-wide policy of establishing permanent forest fire observation stations on all the principal heights in the State. We now have a total of 37, of which 32 are of steel construction of our own design, and most of which have been erected by our State Fire Warden, Mr. M. C. Hutchins, and his own men.

Besides doing our own construction work, which has been a great saving in expense, about 150 miles of telephone wire have been put up by these same men, largely through the woods, for connecting these towers with local towns and cities, thus enabling the observer to give warning and get fire fighters when needed. This service now reaches 1,800 forest wardens and their deputies throughout the State. Our forest fire loss has been less than $100,000 a year on the average since 1911, when it was over $600,000. About 20,000 permits for setting fires were issued during the year. Many towns have taken advantage of the reimbursement act, the total paid to date amounting to $22,000. The towns themselves have spent an equal amount. Ten thousand cloth fire notices have been distributed throughout the State during the year, and a new forest-fire motor truck was installed in Worcester County, making two now owned by this department. This auxiliary equipment will prove to be a great insurance for the State's forest lands against fire.

The district forest wardens examined about 1,000 railroad locomotives during the year. We were allowed $3,000 by the Federal government in our co-operative forest fire work. This in brief is a comprehensive statement of our present accomplishments in this work.

During the past year we have continued the work of aiding woodland owners in the utilization of their forest products, both

in operating and marketing. In each case, however, the work has been done with a definite purpose in view, namely, that the property treated should be given proper forest culture for future results. In all this work the capital used was furnished by the owner and this department simply supervised the operation. It is believed such practical demonstrations are greatly appreciated, and will go very far in showing our woodland owners the best way to handle their forest property. A very fair showing was made in utilizing much of the chestnut dying of the blight; also in the use of oak stands that have been injured as the result of the gypsy and brown-tail moth depredations.

The gypsy moth work during the past season, taking everything into consideration, was handled even better than was anticipated. The oldest infested sections of the State were practically free from stripping. The worst conditions, as was expected, were to the south of Boston, particularly on the Cape, and to quite an extent throughout Norfolk County. The Cape has become generally infested, and the residents of that part of the State have come to our assistance and are co-operating with this department in getting equipment and materials to work with. While the conditions are really at their worst, and have been for two years, still, it is predicted by the writer that conditions will improve rapidly throughout this section in a few years. In Norfolk County we find in many sections a very large acreage of hardwood and pine mixtures, wherein white oak and gray birch play a very important part. As these two species are the ones most sought after by the gypsy-moth larvæ, it naturally follows that these conditions are ideal for their development. Where it is practicable to free white pine stands of oak and birch it is advisable. Many of the towns in this section are not properly equipped with modern spraying machines and trained men to cope with the situation. It is believed more and better attention, however, can be expected here next season.

Throughout Middlesex County a vast amount of very constructive work has been accomplished this year through a well-directed effort in inducing the woodland owners to eliminate the food trees that are preferred by the moths to others. These thinnings have been utilized largely as firewood, cut up into 12

and 16 inch lengths and have found a ready market. A number of cities and towns have purchased portable machines which are available for this work. A charge is made per cord so that the equipment is finally paid for, and the local town official charges for the services of himself and crew. This work was carried on in 12 cities and towns the past year, with a total of 3,000 cords of wood made available for domestic use. From this experience it is demonstrated that a great deal of desirable fuel can thus be made available, and at the same time the woodlands can be improved by the operation.

The brown-tail moth made its appearance again last spring to a limited extent in widely different sections of the State. One of the largest colonies was found along the New Hampshire line in Salisbury, where about 2,000 nests were destroyed. A second outbreak of importance was in Central Worcester County. In every case they were closely scouted and destroyed. Special instructions have been sent out to all local officials to use very drastic measures in dealing with this insect wherever found.

The work in co-operation with the cranberry growers has resulted in a much better understanding of the problem of preventing the gypsy moths from devastating the bogs. A report of the cranberry committee is printed elsewhere.

An important meeting of the North Shore people, composed of both the summer and permanent residents, was held at the Horticultural Hall, Manchester, on September 12, at which time the State Forester gave a talk emphasizing the importance of forestry to the section, and pointing out where certain lines of work could be done. A permanent organization was perfected, and a second meeting was held on November 10, when plans were outlined for future work and various committees reported progress. As this section of the State is very progressive, it is to be expected that some very excellent work will be the outgrowth during the coming year.

During the latter part of July and the first part of August the State Forester spent two weeks in the Berkshires, making headquarters at the Forest Lodge on the Arthur Wharton Swann State Forest. Daily trips were taken from here, making a study of the conditions of the whole section and meeting many forest

owners. At this time plans were perfected for operating the blighted chestnut on the Swann State Forest the present winter. The Savoy State Forest was also carefully examined on this same trip, at which time it was noted that the plantations here were doing exceptionally well.

On November 5 the State Forester and two of his assistants had a conference with a committee of the Eastern Shook and Wooden Box Association at the City Club, Boston, at which time plans were outlined for definite future co-operative work with that association and the New England State forest officials. It is believed that much good may result to future forestry in bringing these interests together.

Organization.

There have been comparatively few changes during the year. Mr. C. R. Atwood, who was in France with the 20th Forest Engineers, has returned and taken up work in the line of forest utilization in the department. Mr. Saul Phillips, who has been in charge of the North Shore moth work for years, resigned to go into corn borer work. Mr. M. E. Fenn, district fire warden, resigned during the year. Mr. J. R. Simmons, assistant in reforestation work, also resigned to accept the position of secretary of the New York State Forestry Association.

The organization of the department throughout the year was as follows: —

General Staff.

F. W. Rane, B.Agr., M.Sc.,	State Forester.
C. O. Bailey,	Secretary.
Elizabeth Hubbard,	Bookkeeper.
Elizabeth T. Harraghy,	Stenographer.
Jennie D. Kenyon,	Stenographer
Mabel R. Hamnett,	Clerk.
Dorothy J. Sanford,	Assistant clerk.

General Forestry.

H. O. Cook, M.F.,	Assistant forester in charge.
James Morris,	Assistant.
Eben Smith,	Superintendent, Barnstable Nursery.
J. A. Palmer,	Superintendent, Amherst Nursery.
H. H. Chase,	Field foreman.
R. B. Parmenter,	Field foreman.
Fred W. Parker,	Field foreman.
John H. Saxton,	Field foreman.
Avery Gardner,	Field foreman.

MOTH WORK.

GEORGE A. SMITH, ... Assistant (equipment, accounts, etc.).
PAUL D. KNEELAND, M.F., . . . Assistant (woodlands, products, etc.).
CHARLES R. ATWOOD, ... Assistant.

District Moth Men.

1. M. H. DONOVAN, Beverly.
2. WM. A. HATCH, Marlborough.
3. JOHN J. FITZGERALD, Haverhill.
4. C. W. PARKHURST, Foxborough.
5. W. F. HOLMES, Wareham.
6. H. B. RAMSEY, Worcester.

FOREST FIRE PREVENTION.

M. C. HUTCHINS, ... State Fire Warden.
JOSEPHA L. GALLAGHER, . . . Clerk.

District Forest Wardens.

1 JAMES E. MOLOY, Woburn.
2. FRANCIS V. LEAROYD, Lynn.
3. JOS. J. SHEPHERD, Pembroke.
4. JOHN P. CROWE, Westborough.
5. ALBERT R. ORDWAY, Westfield.

Observers and Location of Fire Towers.

MRS. JOHN CONDON, Harwich.
JOSEPH W. JENKINS, Barnstable.
W. I. MOODY, Falmouth.
W. F. RAYMOND, Bourne.
F. L. BUCKINGHAM, Kingston.
MRS. ALLAN KENISTON, Martha's Vineyard.
S. EDWARD MATTHEWS, Middleborough.
JOHN H. MONTLE, Fall River.
R. J. ZILCH, Rehoboth.
CHAS. F. KIMBALL, Hanson.
EDWARD D. SPRAGUE, Hingham.
JAMES E. SULLIVAN, Sharon.
FRED R. STONE, Sudbury.
WM. H. TYZZER, Jr., Wakefield.
C. E. BLOOD, Chelmsford.
OSCAR L. NOYES, Georgetown.
CAPLIS MCCORMACK, Manchester.
ROBERT MCLAUGHLIN, Mendon.
MICHAEL E. LYONS, Westborough
JAMES W. MALEY, Wachusett Mountain.
MARK W. SHATTUCK, Watatic Mountain.
WM. E. TAYLOR, Warwick.
HARLAND BURROWS, Pelham
GEO. B. SHERMAN, Brimfield.
THOMAS MAGOVERN, Charlton.
E. J. VAILENCOURT, Mount Tom
N. C. WOODWARD, Shelburne Falls.
H. H. FITZROY, Savoy.
DAVID M. SMITH, Waltham.
ELMER HUNT, Chester.
JOHN E. CURTIN, Tolland.
CLAYTON BUNT, Mount Everett.
ROBERT MILLER, Lenox.
HARRY GEORGE, Williamstown.
ALTON B. ELLIS, Acushnet.
ALVA SIKES, West Brookfield.

STATE FORESTS.

The year has been marked by considerable progress in the development of our State forests. This was made possible by the decision of the State Forest Commission to expend about $20,000 of its appropriation in this work.

At our largest State forest, the Myles Standish, in Plymouth, 480,000 white and Scotch pines were planted during the spring. A new nursery site was selected in the rear of the bungalow, a

water system installed, and 250,000 pine seedlings transplanted into it. The fire warden has erected a small steel observation tower and extended the telephone to the bungalow. The boundary lines, 22 miles in length, have been mowed over, and about 8 miles of the principal roads bushed out. Some 10 acres of scrub oak growth near the buildings have been cleared, partly as a means of fire protection and partly to assist the fine pine plantation growing therein. We are greatly encouraged by the results that some of the white pine plantations set out in scrub oaks six years ago are showing in this type of land. A new garage has been built near the superintendent's house, and a few minor repairs made on buildings.

On the Harold Parker Forest 45,000 white pines were set in the west section, and two or three old cart roads bushed out.

On the Otter River Forest 175,000 four-year-old white pine transplants, all from the nursery on the forest, have been planted, and 300,000 seedlings have been set in the nursery. An old town road and two or three cart roads in the south part of the forest have been bushed out, and the fire lines along the railroad and electric line have been kept in repair.

At the Savoy Mountain Forest 145,000 trees, largely spruce, were planted, and 150,000 pine and spruce seedlings were set in the nursery. There is so little brush land on this forest, and so much of it is made up of clear, open pasture lands, that the bushing of land or roads does not appear in the administrative work.

On the Swann Forest no planting was done, but a small nursery was started with 40,000 seedlings. The forester who has charge of our work in the western part of the State lives in the farmhouse, and makes this forest his headquarters. This arrangement provides a caretaker for the forest at no direct charge to the forest itself. The chief problem in connection with this forest is the utilization of 300 acres of chestnut which are dead or dying, and many of which are below a merchantable size. The State Forester received from the General Court an appropriation of $10,000 to operate this land. Work has already commenced under the forester in charge of utilization, and will continue during the winter.

Expenditures for 1919 on State Forests.

In accordance with the provisions of section 3, chapter 720, Acts of 1914, the State Forester herewith gives a statement of the expenditures on each State forest for the past year.

State Forest.	Planting Expenses.	General Upkeep, Fire Lines, Roads, etc.	New Land.	Total.
Myles Standish,	$3,975 23	$3,609 02	$450 00	$8,034 25
Harold Parker,	523 71	1,064 37	242 00	1,830 08
Otter River,	1,642 16	1,744 37	40 00	3,426 53
Savoy Mountain,	1,010 10	1,190 32	1,540 00	3,740 42
Arthur Wharton Swann,	-	1,168 32	-	1,168 32
Total,	$7,151 20	$8,776 41	$2,272 00	$18,199 61

State Plantations.

The term "plantation" is applied to those smaller tracts of land, some of which are given to the State, in distinction from the large tracts which we call State forests. Four small tracts were added during the year, so that the total number is now 165. Sixteen lots were reforested in whole or in part during the spring, half of which were new lots which had not been reforested before, and the other half were lots previously planted, but which needed replanting in part. Two hundred and fifty-five thousand transplants were used in this work. In addition, on 13 lots brush was cut, either preparatory to planting or to release from suppression pines set out in previous years. Two hundred seventy-five acres were gone over in this way.

Reforestation Work.

Planting.

[W. p.=white pine; r. p.=red pine; A. p.=Austrian pine; S. p.=Scotch pine; s.=spruce; f.=fir.]

Lot.	Town.	Area (Acres).	Trees.
Baker-Haven,	Rutland,	20	5,000 w. p.
Civic League,	Nantucket,	50	30,000 w. p. 5,000 r. p. 3,500 A. p. 1,500 S. p.

PLANTING — *Concluded.*

Lot.	Town.	Area (Acres).	Trees.
Baker-Hurd,	Barre,	132	12,000 w. p. 3,000 S. p.
Baker-Thompson,	Hubbardston,	36	5,000 S. p.
Baker-Kendall,	Hubbardston,	72	26,000 w. p.
Schley,	Rockport,	70	12,000 w. p. 3,000 s. 2,000 r. p.
Geer,	Belchertown,	7	4,000 w. p. 4,500 S. p.
Barber,	Chelmsford,	4	4,000 r. p. 500 s.
Thayer,	Leicester,	18	10,000 w. p.
Leonard,[1]	Raynham,	16	5,000 w. p.
Fullam,[1]	Oakham,	22	8,000 w. p.
Hansen,[1]	Marlborough,	100	26,000 S. p.
Smith,[1]	Barnstable,	17	10,000 r. p.
Harrington,[1]	Westminster,	100	10,000 S. p. 26,000 w. p.
McLaughlin,[1]	Sandwich,	52	20,000 r. p.
Weeks,[1]	Sandwich,	20	2,000 f.
Town,[1]	Templeton,	60	4,000 w. p.
Dean,[1]	Rutland,	70	10,000 S. p.

[1] These lots were filled in after original planting.

BUSHING.

Lot.	Town.	Area (Acres).	Brushed.
Briggs,	Oakham,	1½	1½
Thayer,	Leicester,	18	18
Baker-Thompson,	Hubbardston,	36	5
Baker-Haven,	Rutland,	20	8
Fullam,	Oakham,	22	10
Johnson,	Ashburnham,	25	25
Shapleigh,	Ashburnham,	32	32
Smith,	Barnstable,	17	17
Harrington,	Westminster,	100	50
Fullam,	Oakham,	115	10
Town,	Templeton,	60	60
Davis & Hadley,	Templeton,	107	12
Chestnut Hill,	Spencer,	300	24

Nursery Work.

Under this heading we include the work carried on at our three principal nurseries at Amherst, Bridgewater and Barnstable, but do not include the product of the nurseries located on the State forests, which are carried on by funds provided for the administration of these lands. In spite of the fact that we made no special effort to sell stock to private parties, and were, in fact, somewhat reluctant to let our stock go in this way, we received orders for almost as much stock as we sold in 1918, when we were putting forth special efforts along this line. Altogether about 500,000 transplants were sold, over 1,000,000 were used in the work of the department, and 300,000 were given to other State departments. We shall not have on hand next spring as much stock as was available this past spring, and the situation for the next two or three years gives us much concern. On account of the blister-rust agitation, which was disastrous to the nursery and forest seed business, followed by war conditions, it has been next to impossible to get forest tree seed for the past three or four years, and that means that our available supply of transplants, instead of increasing as it should, will be below normal in amount for some time. In this respect all forest nurseries, both private and State, are in the same condition. Had the conditions remained normal, our Massachusetts program would easily have enabled us to have been planting at least 10,000,000 trees throughout the State during the past year. The demands for white pine stock exceeded our supply, and, contrary to expectation, the red pine was not very popular, although we had an exceptionally fine stock. The Scotch pine, due to various causes, particularly the damage from girdling by mice two years ago, was generally avoided. Regardless of the danger from blister rust, our lumbermen and larger planters insist on using white pine, preferring to take their chances for results with this species. Our nurseries are all in excellent condition.

A plantation made in the town of Sandwich. The land is typical Cape sand. The trees here shown are red pine. White and Scotch pine are doing equally well. Four-year transplants were most successful in planting.

A hedge of white and Scotch pine set out in pure sand as a protection to one of our plantations on the Cape. The trees were strong transplants when set. The Scotch and white pine have both proved a great success. The Scotch are leading the white pine in height growth, although the latter are doing well.

Stock used by Forestry Department.

Species.	Class.	Number.
White pine,	4-year transplants,	605,000
Scotch pine,	4-year transplants,	270,000
Red pine,	4-year transplants,	68,000
Spruce,	4-year transplants,	140,000
Austrian pine,	4-year transplants,	6,000
Total,		1,089,000

Stock sold to Private Owners.

Species.	Class.	Number.
White pine,	4-year transplants,	278,000
White pine,	5-year transplants,	40,775
Red pine,	4-year transplants,	51,200
Scotch pine,	5-year transplants,	14,200
Scotch pine,	4-year transplants,	102,402
Spruce,	4-year transplants,	19,052
Arbor vitæ,	– – –	4,500
Hemlock,	– – –	1,700
Douglas fir,	– – –	8,550
White pine,	2-year seedlings,	10,000
Total,		530,379

Stock used by Other State Departments.

Species.	Class.	Number.
White pine,	5-year transplants,	2,000
Scotch pine,	5-year transplants,	2,000
Spruce,	4-year transplants,	1,000
Arbor vitæ,	– – –	1,000
Douglas fir,	– – –	1,000
White pine,	3-year seedlings,	250,000
Total,		257,000

INVENTORY OF NURSERY STOCK.

SPECIES.	4-Year Transplants.	3-Year Transplants.	2-Year Seedlings.	1-Year Seedlings.
White pine,	830,000	1,740,000	925,000	350,000
Red pine,	261,700	125,000	-	-
Scotch pine,	50,000	330,000	350,000	32,500
Austrian pine,	22,000	-	-	-
Spruce,	135,000	60,000	400,000	100,000
Ponderosa pine,	25,000	-	-	-
Jack pine,	-	140,000	-	190,000
Larch,	10,000	-	2,000	3,600
Arbor vitæ,	-	-	-	45,000
Hemlock,	-	-	4,000	9,600
Engelmann spruce,	-	-	-	22,000
Douglas fir,	-	-	-	155,000
Totals,	1,333,700	2,395,000	1,681,000	907,700

In addition to the above we have the following stock in the nurseries: —

White pine 3-year seedlings,	200,000
Spruce 5-year transplants,	14,000
Arbor vitæ 7-year transplants,	11,200

BLISTER-RUST ERADICATION.

Through a co-operative agreement with the nursery inspector of the State Department of Agriculture it was decided to put on a crew of men during the summer in scouting certain of our plantations for wild currant and gooseberry in order to prevent the spread of pine blister rust. The plantations selected were those on which German-grown pines were set in 1909, and which therefore were known, or strongly suspected, to have trees infected with the blister. In 1914 these same lots were scouted for infected pines, but the ribes had not been removed. The nursery inspector bore three-fourths of the total cost of $1,600. The following table gives the result of this eradication work. It will be noted that on some lots no currants whatever were found, while on others there were thousands, showing great irregularity in the distribution of these plants. The figures for infected pines mean little, as no attempt was made to examine them.

BLISTER-RUST ERADICATION.

LOT.	Area examined.	RIBES ERADICATED.			Infected Pine.
		Infected.	Not infected.	Total.	
Templeton,	55	–	887	887	1
Davis,	152	–	51	51	–
Lamb,	48	–	–	–	–
Bent,	58	–	8,553	8,553	–
Fenno 1 and 14,	110	16	52	68	–
Fenno 2,	128	–	10	10	–
Whitney,	147	170	2,030	2,200	13
Fenno 15,	77	–	171	171	–
Heywood,	189	3,210	50,982	54,192	2
Lynde,	108	2	398	400	–
Derby,	26	–	–	–	–
Smith,	96	–	55	55	–
Totals,	1,194	3,398	63,189	66,587	16

EXAMINATIONS.

The number of applications for examination of private woodlands and trees was far less than the number of the previous year, — smaller, in fact, than for many years. There is no doubt that the high price of common labor is a great detriment to the practice of forestry, and most woodland owners are very much inclined to postpone any work that will not give an immediate profit.

LIST OF EXAMINATIONS BY SUBJECTS.

SUBJECT.	Number.	Acres.
Thinning,	16	897
Thinning and planting,	5	215
Planting,	5	1,062
Estimate,	8	556
Chestnut blight thinning,	2	200
Insects and diseases,	1	50
Cutting,	1	220
General,	3	976
Totals,	41	4,176

Tree Planting in 1919.

A total of 787,379 trees of white, Scotch and red pine, with a few thousand of other varieties, was planted in the spring of 1919. This stock was sold to the public from our nurseries at an average price of $8 per thousand or furnished to other State departments free of charge.

These trees were distributed throughout the State among the following 80 towns and cities: —

Acushnet,	50,000	Hubbardston,	1,000
Amesbury,	2,000	Hudson,	26,100
Amherst,	2,100	Huntington,	5,000
Andover,	13,000	Hyde Park,	1,500
Ashland,	3,000	Lancaster,	1,000
Ayer,	7,000	Leominster,	12,000
Barnstable,	3,000	Lowell,	12,000
Barre,	1,000	Lynn,	31,000
Beverly,	7,000	Marlborough,	4,250
Boston,	5,000	Mattapan,	150,000
Boxford,	11,000	Mattapoisett,	1,000
Brockton,	3,350	Maynard,	2,000
Cambridge,	100	Millbury,	1,000
Carlisle,	4,000	Milton,	1,000
Charlemont,	5,000	Nantucket,	1,500
Chatham,	450	Newton,	14,500
Clinton,	300	North Attleborough,	16,000
Cohasset,	1,000	Northampton,	48,000
Concord,	3,000	Norwell,	9,500
Danvers,	3,000	Oak Bluffs,	1,000
Dover,	23,000	Orange,	1,000
Edgartown,	1,500	Palmer,	2,000
Falmouth,	5,000	Pittsfield,	300
Fitchburg,	41,000	Plymouth,	1,900
Foxborough,	1,100	Princeton,	1,000
Framingham,	1,000	Raynham,	5,000
Gardner,	1,000	Rutland,	1,000
Granby,	2,300	Sherborn,	3,000
Great Barrington,	10,250	Shrewsbury,	1,150
Greenwich,	1,550	Southborough,	100,000
Groton,	3,000	Southwick,	4,000
Hadley,	2,000	Sudbury,	3,000
Harvard,	10,000	Topsfield,	1,000
Holyoke,	10,000	Waltham,	6,000

One of the four horse-power sprayers loaded on a Ford truck. This is a very convenient and handy spraying outfit for general use and a popular one with moth superintendents.

A country roadside properly thinned and cared for as regards moth work, convenience of travel, forest-fire dangers and æsthetic beauty.

Wareham,	36,200	Winchendon,	1,000
Warren,	1,000	Winchester,	15,000
West Boylston,	2,000	Woburn,	200
West Brookfield,	79	Worcester,	500
Westborough,	3,000	Wrentham,	200
Westford,	2,000	Yarmouth,	1,000

The species sold were distributed as follows: —

White pine,	580,775	Hemlock,	1,700
Red pine,	51,200	Arbor vitæ,	5,500
Scotch pine,	118,602		
Douglas fir,	9,550	Total,	787,379
Norway spruce,	20,052		

Gypsy Moth Spraying Work.

During the past year our spraying equipment has been greatly augmented by new outfits in various cities and towns. Almost all of our towns and cities that have large shade trees and woodlands have purchased at least one high-power sprayer, while many have more than one. A sprayer that is very practical and convenient is the so-called "four-horse," which can be carried about on a Ford truck or one-horse wagon, and has good power. This sprayer covers trees of ordinary height, and the ease with which it is transported makes it a fine auxiliary to the large sprayer. On the Cape it has become the most popular of any. Besides its use with trees it is a convenient size for spraying the cranberry bogs. The fact that for the same expenditure of money a town can secure at least three of these small sprayers instead of one large one, that they can be manned by a much smaller crew, and that all three can be working in different parts of the town at the same time are points in their favor which tend to popularize their use. They also are well adapted for spraying orchards and for private work in general. As there has been a great tendency for the moth superintendents to do this work, this equipment serves that purpose well. The ideal arrangement in the ordinary town is to depend upon the larger standard sprayer for the State highways and thickly settled residential sections, where the trees are usually very tall, like the elms, while other work may be handled by the four-horse-power sprayer. Generally speaking, it will require the constant

use of the high-power standard sprayer to cover the streets alone, for most towns have a very large mileage.

We are of the opinion that the time is rapidly coming when spraying and creosoting the egg-clusters in alternate years will be the practical method. In this case each can be done more thoroughly. This plan, it is believed, should be considered in the towns that have been infested for some time. We are satisfied that spraying with arsenate of lead is the most satisfactory way to combat the gypsy moth. When it is recognized that these same sprayers are of equal importance in spraying other insects and diseases which are bound to appear occasionally, they become a good investment. There is no section in America, after all, where better and more intelligent care is given to trees than here in Massachusetts, and this fact is due to the careful study and highly developed equipment that has resulted from our necessary struggle to suppress the gypsy and brown-tail moths. The motor-truck sprayers have not been alluded to, as these are more expensive, and while they are well adapted to the State highway work, and to some of the wealthier towns and cities, it is questionable as to just how practical they are for general use. It is only a matter of time when a smaller and more convenient type of power-truck sprayer will be perfected, it is believed.

Dry v. *Paste Arsenate of Lead.*

During the past season we concluded to use the dry or powdered form of arsenate of lead on a much larger scale than heretofore. Our contracts, therefore, were placed for about one-half each of the dry and the paste lead. The plan was also carried out of furnishing the towns and cities with about equal amounts of each ingredient. As a result of this experiment we have become assured that the dry or powdered form is greatly preferred. It has been greatly perfected by the manufacturers during recent years and the standard brands now being offered by reputable companies are very reliable. The dry form is far less bulky, and hence easier to handle and more convenient. Manufacturers are putting the dry lead up in small packages of just the right amount for charging our standard spraying tanks, and this is far more convenient than the old method of

weighing out the required amount from a barrel of paste lead. It is also proving more economical, as there is far less waste, and the amount used is more uniform. We are so well pleased with the dry lead that it will probably supplant the paste form in the near future if not the coming season.

Moth Thinning and Utilization Work.

During the past year the work of operating in co-operation with private individuals, either for the amelioration of gypsy-moth conditions or to help in proper forest management, has progressed in all sections of the State. A list of the operations on which work was done during the past year is appended. On these operations about 3,000 cords of wood were cut and about 1,400,000 feet of lumber. About $42,000 of capital, supplied by private individuals, were expended in carrying on the operations. They were all of the type where the returns are in excess of the amount of capital expended, and should all lead to a profit, many of them to a substantial one. The work has not gone on as fast as was anticipated at the beginning of the year, due to the great difficulty in obtaining labor. Also the transition period between war and peace has made it inadvisable to do too much, especially in the line of producing cordwood, the market for which is still very uncertain. For that reason a number of operations that might otherwise have been carried on have been postponed to some future time. A number of changes in the personnel of that branch of the work have also hindered its efficiency. It is hard to obtain men capable of carrying on practical operations and compete in wages against the many openings which are offered by private business.

Twenty-five formal examinations of woodland were made during the year, covering about 3,800 acres. Besides that a large number of informal examinations were made where only part of the area was examined or special advice only was asked.

Five different meetings were addressed during the year, where talks were made on the subject of operating along forestry lines or the utilization of forest products. A bulletin is in preparation on the subject of portable sawmills operating in Massachusetts.

OPERATIONS.

OWNER.	Location.	Area (Acres).	Character.
Francis R. Bangs, . . .	Wareham, . . .	40	Cordwood and planting.
H. W. Bennett, ...	Marion, . . .	100	Wood machine.
D. C. Brewer, ...	Harvard, . . .	130	Sawmill and cordwood.
E. F. Greene, ...	Wayland, . . .	110	Sawmill and cordwood.
J. W. Helburn, ...	Housatonic, . .	70	Sawmill and cordwood.
R. M. Johnson, ...	Andover, . . .	10	Planting.
J. E. Maynard, ...	Harvard, . . .	16	Sawmill.
Sharon Sanatorium, . . .	Sharon, . . .	90	Sawmill and cordwood.
Joseph Skinner, ...	Hadley, . . .	50	Planting.

MINOR WOODLAND OPERATIONS.

In the eastern part of the State there are innumerable small tracts of woodlands which, due to gypsy-moth infestation, forest fires, chestnut blight, etc., need attention. During the past year very strenuous efforts were put forth to give object-lessons in solving this problem. Whenever tracts could be obtained and the owners interested it was undertaken, provided the operation was along a well-traveled road or in a conspicuous place. The idea at all times was to show, through a practical demonstration, how these woodlands may be treated so as to derive the most out of them at the present time, and leave them in a condition for producing maximum crops of superior value in the future.

In addition to the utilization methods commonly practiced heretofore of cutting into lumber, ties, poles and cordwood, a portable circular-saw equipment capable of receiving sticks of wood of long or unequal lengths, and thus converting them into stove or furnace sizes in one concerted action in the woodland itself, has been the means of aiding in making this work practical and effective.

This equipment has come into use when cordwood choppers are scarce, and by cutting in full lengths the few skilled choppers were thus used to great advantage. Another condition has also prevailed that has been favorable, in that coal was short and

A gypsy moth forest thinning, showing the logs and cordwood removed. The white pine stand remaining will be immune from the moths. This operation was carried on in the town of Burlington on the Simonds estate.

The product of one town's portable circular saw outfit in Lunenburg. Cut into these short lengths it meets a popular demand. The owner was able to dispose of his whole product of about a thousand cords on the lot.

the demand for 12 and 16 inch fuel wood was very general. Many of these operations sold the entire product on the lot, so eager were purchasers to secure it.

Operations were carried on in the towns and one city as listed below: —

Place.	Number of Operations.	Acres.	Cords of Wood.
Bedford,	1	20	125
Bolton,	1	6	45
Burlington,	1	30	60
Chelmsford,	3	35	75
Fitchburg,	1	30	150
Groton,	4	70	180
Harvard,	1	45	80
Lunenburg,	2	80	1,000
Pepperell,	2	20	70
Sudbury,	2	15	90
Tyngsborough,	1	40	150
Waltham,	1	40	208
Total,	20	431	2,233

Woodland operations of like character took place in Marlborough, Sherborn, Dunstable, Hudson and Framingham, under our supervision, with a total of over 1,000 cords, but without the use of sawing equipment.

A municipal plant was installed at the advice of the State Forester in the city of Boston. Superintendent Long has, besides two circular-saw outfits, a permanent sawmill. This arrangement allows him to utilize all of the small trees and limbs for fuel wood, and the larger trees for lumber.

Gypsy-moth Work in protecting Cranberry Bogs.

Co-operative work with the cranberry growers has continued through the year. In fact, the Cape Cod Cranberry Growers' Association complimented the department by electing the State Forester's representative in charge of the work in that division of the State, Mr. Walter F. Holmes, as a member of their executive committee. The seriousness and importance of this

work should not be overlooked, for this industry is far more important than most people realize. The following report, which was written by Mr. Holmes, was sent in with the approval of Pres. James T. Hennessy of the above-named association: —

Previous to 1918 bog work centered mostly in the town of Carver, with a small amount of work done in Mashpee and Harwich. Since then we have extended cutting operations into Pembroke, Kingston, Duxbury, Plymouth, Lakeville, Rochester, Bourne, Falmouth, Mashpee, Barnstable and Plympton, with spraying operations so extended as to include all towns in which cranberry bogs are located.

Mr. J. Myrick Bump, chairman of the Cape Cod Cranberry Growers' Committee, has been of especial assistance to us through his knowledge of bog conditions and the splendid co-operation of his committee.

Recently Dr. Franklin of the State Experimental Cranberry Station has offered his services in connection with this work to our local moth superintendents; also he will conduct a special field service to co-operate with our work during the caterpillar season. We are planning to hold meetings at Plymouth and Buzzard's Bay early in January, and field meetings during the month of May.

There is no doubt but that the gypsy moth has become a serious menace to the cranberry industry. The great majority of cranberry growers do not know how to combat it, and until recently were unable to carry on spraying operations through lack of proper equipment. This is being overcome at the present time, I am happy to say, and our personal efforts to instruct the individual grower as to his duty should be of everlasting benefit to all concerned.

We especially call to the attention of the towns in which cranberry bogs are located the importance of this industry to the community, and urgently request that proper spraying equipment be provided whereby this work may be done at a reasonable expense; also we would suggest to all growers who have fifteen or more acres under cultivation the desirability of owning their own spraying equipment.

The State Fire Warden's Report.

Mr. F. W. Rane, *State Forester.*

Sir: — In compliance with your request, and in accord with the provisions of chapter 722, section 2, Acts of 1911, I beg to submit the following report of the work accomplished by this branch of the department this year.

The fire season in general has been a very favorable one. While we experienced unfavorable conditions from April 20 to May 20, when we had nearly 900 fires, the damage from these fires was very low compared with other years, this being undoubtedly due to our observation system,

which is nearing completion, to the stronger forest fire organization that has been built up in towns by our district forest wardens, together with the assistance rendered by the district forest wardens in furnishing extra supplies of forest fire equipment where necessary. This extra equipment is carried by this department for use in emergency cases, such as large fires that have gone beyond control, or for use in small towns that have as yet been unable to procure even a small amount of forest fire fighting equipment to enable them to handle their fires. This department is equipped now with two complete forest fire outfits, one located in Westborough and one in Westfield. Both outfits are equipped with motors, and are sufficient for any ordinary fire. We hope that we shall soon be able to have apparatus of this kind for use in Plymouth and Barnstable counties. While most of the Cape towns are very well equipped for handling their forest fires, at the same time, special motor equipment of this nature could be centralized at the Myles Standish State Reservation, thus giving the reservation additional protection, and be available for use throughout the two counties.

We have had in operation this season 36 fire observation stations, from which more than 1,400 fires have been observed and reported. These stations are equipped with topographical maps, alidades, powerful field glasses and telephones, which enable the observers to report with promptness and accuracy to the forest wardens or deputies the location of the fires.

We purchased this year the summit of Mount Grace, Warwick, and replaced the windmill tower which has been in use there for seven years with a large 8-ton steel tower, 70 feet high, with stairs, and a 10 by 10 foot room at the top. The station has always been a very important one, and with the new tower giving additional height overlooks thousands of acres of forested area in Massachusetts, as well as a large amount of territory in New Hampshire. The towns of Athol, Erving, Northfield, Orange, Royalston and Warwick contributed $900 towards the cost of this station.

The old windmill tower, formerly in use at Chelmsford, and replaced last year with a 70-foot steel tower, has been erected on the Myles Standish Reservation. An addition of 10 feet was made to it, and it now forms a part of the protective system of the reservation. The exterior of the Falmouth, Waltham, Westborough and Chester towers and the interior of nearly one-half of the towers in the State were painted. The new tower at Chester, which was not entirely completed last year, was finished and in operation a portion of this year.

The roads leading to many of the observation stations have been improved, so it is now possible to drive by automobile to them. This has increased the number of visitors, so that over 13,000 pleasure seekers coming from not only Massachusetts, but representing nearly every State in the Union and several foreign countries, have visited them.

A new forest fire truck was purchased and is centrally located at West-

borough. This is used for forest fire work during the fire season, and on construction work during the balance of the year.

Forest warden conferences were held during the months of February and March in the following places: Barnstable, Fall River, Middleborough, Salem, Lowell, Greenfield, Worcester, Springfield, Gardner and Northampton. These meetings were well attended by forest wardens, deputies and selectmen, and a great deal of interest was shown in the following discussions: the necessity of providing towns with better forest fire fighting equipment; instructions to wardens and deputies as to the best methods of handling extinguishers, pumps and other equipment at fires in order to accomplish the best results; the enforcement of the forest fire laws; the importance of promptly reporting all fires to this department; and railroad fires, with instructions as to how to make out railroad fire pay rolls in order that towns may be reimbursed promptly for money expended in extinguishing them. The railroads were represented by the following claim agents: Boston & Maine, E. A. Ryder; New York, New Haven & Hartford, C. B. Rood; Boston & Albany, C. C. Cone; and the Central Vermont, Mr. Goodell. Owing to the interest shown in and good results from these meetings, it seems desirable to continue them again this year.

We have had 549 railroad fires during the season, as follows: Boston & Albany, 107; Boston & Maine, 48; Central Vermont, 8; New York, New Haven & Hartford, 386. These fires burned over an area of 3,242 acres, causing a damage of $13,319, and costing to extinguish, $4,871. This is the lowest railroad fire damage we have had in several years. Over 700 locomotives have been examined by the department, and while some serious defects have been found, especially in locomotives running on branch lines, most of the defects have been minor, and promptly repaired.

The question of adequate fire protection for our State-owned reservations is a matter that must receive serious consideration. We have now five State reservations comprising over 12,000 acres, and with the exception of the Myles Standish Reservation of 7,000 acres, in the towns of Plymouth and Carver, very little work has been done along this line. Around the entire reservation a narrow fire line has been made, roads have been bushed out and some fire lines made inside the reservation. A small amount of forest fire fighting equipment is also kept here for use.

If the State is to continue its policy of reforesting this reservation, more adequate fire protection must be provided. The fire line around the entire tract must be widened, making it especially wide on the southern and western sides. Inside the reservation, and especially where we have extensive plantations, the territory should be divided into a relatively small area of from 300 to 500 acres in extent by wide fire lines. These fire lines should be made along the present roads by widening out the existent lines. Then, by providing additional forest fire fighting equipment, with one or two small motor trucks for transportation, we shall be able to confine a fire to a given area.

The Forest Commission during the year established the policy of leasing camp sites around the several ponds, which means that probably 120 sites will be leased on this reservation by June 1 next. This of course adds to the fire danger by bringing in possibly 500 pleasure seekers. On the other hand, it gives us a surplus of help to draw from in case of fire. Wide fire lines should be constructed around these camp lot ponds, and also along the roads leading to the ponds. These fire lines would of course serve two purposes, — the protection of the campers from fires coming on to the reservation, and the protection of the reservation from fires coming from camp site owners. The original cost of construction will vary with the amount and character of the growth to be cleared, but the expense of maintenance should be very low.

The revenue received from camp sites, which will be about $1,200 per year on this reservation alone, could be reappropriated each year, thereby providing funds which we believe will be ample for maintaining the fire lines on this reservation after they are once installed.

The fire conditions on the other reservations are very different; there is very little fire risk at present, and the possibility of leasing a large number of camp sites is not so promising, owing to the lack of ponds and ideal conditions for campers. We are, however, reforesting considerable territory on each reservation, and ample precautions should be taken by constructing fire lines around these plantations and providing sufficient equipment for extinguishing any fires that may occur.

It seems advisable that a fire observation station be established on the summit of Proven Mountain, which is located on the town line between Agawam and Westfield, on land owned by the city of Springfield. We have endeavored in the past to protect the towns in this locality from our station at Mount Tom, but have been unable to get to fires promptly enough to be of distinct advantage to the towns. This is an extremely dangerous fire section, and a station here would lessen the fire danger very materially. An extension should be added to the fire tower located at Hanson. The present tower is 48 feet high and was erected six years ago. The growth around this station has been so rapid that the view is somewhat obstructed on two sides, and a 20-foot extension is desirable.

Many of the towns, especially in the eastern part of the State, now own motor equipment, which enables the wardens to get to fires quickly, and to extinguish them before any serious damage has been caused. Throughout the central and western part of the State conditions are different. The towns are not as well-to-do, and it is extremely difficult to convince the town authorities of the importance of supplying their wardens with equipment, and better protecting their forested area.

As a large percentage of our woodland lies throughout this locality and within the poorer towns, it is certain, if this timberland is to receive proper protection, the State must assist them in addition to reimbursing them 50 per cent of the cost of the forest fire fighting equipment, and must assume some of the expense caused in extinguishing fires. All of the New

England States, with the exception of Massachusetts and Rhode Island, assume a portion of the forest fire fighting expense throughout their forested towns, and until such time as Massachusetts comes to the assistance of these smaller towns this forested area will not receive the protection it deserves.

We called attention in the last annual report to the unsatisfactory results accomplished in the enforcement of our present slash law, and endeavored through the General Court to have this law amended, but were unsuccessful. We are not getting results under the present law, and will not until this department can assume some authority in the enforcement of it. It seems advisable that another effort be made to amend this act, giving a clearer conception of what is required, and placing the responsibility of its enforcement with this department.

The law requires that forest wardens shall be appointed by the selectmen during the month of January. As many selectmen fail to make this appointment at this time, and frequently it goes over until after the annual town meeting, it seems necessary that the law be amended authorizing the State Forester to make such appointment in all cases where it is not made by the selectmen during the month of January. The reason for this is there is not sufficient time to complete our town fire fighting organization before the personnel of the force is needed at our observation stations.

Again this season we have had the hearty co-operation of the Blue Hills Meteorological Bureau. We find it a distinct advantage, especially during a drought, to be able at a moment's notice to get valuable weather forecasts which we can transmit to our observer, as so much depends, not only upon when rain is expected, but also upon wind direction and velocity, all of which play an important part in extinguishing forest fires.

The usual large number of permits for burning brush and rubbish have been granted. During the early spring several arrests were made of parties violating the permit law, some of whom were convicted and fined, while others were allowed to settle by paying for the cost of extinguishing.

Over 8,000 cloth fire notices were distributed throughout the Commonwealth. These were posted by the town forest wardens and our district men in country stores, railroad stations, camp grounds, along streams and in other conspicuous places.

We have co-operated again this year with the Federal department under the Weeks law, and were allotted $3,052, to be expended in salaries of observers. This has enabled us to carry nine men for the entire season on the Federal pay roll. Owing to the increase in salaries which must be paid to observers, it is necessary that a larger amount be allotted for this coming year.

Respectfully submitted,

M. C. Hutchins,
State Fire Warden.

TOWNS RECEIVING FIRE-EQUIPMENT REIMBURSEMENT DURING 1919.

Avon,	$28 78	New Salem,	$57 00
Belchertown,	18 00	Orleans,	60 30
Bellingham,	30 63	Otis,	75 00
Boxford,	3 00	Peru,	19 50
Erving,	37 50	Washington,	21 75
Gosnold,	125 00		
Halifax,	8 00	Total,	$498 46
Montgomery,	14 00		

COMPARATIVE DAMAGES BY FOREST FIRES FOR THE PAST TEN YEARS.

YEAR.	Number of Fires.	Acreage burned.	Cost to extinguish.	Damage.	Average Acreage per Fire.	Average Damage per Fire.
1910,	1,385	42,221	$23,475	$205,383	30.46	$148 20
1911,	2,356	99,693	47,093	537,749	39.31	226 24
1912,	1,851	22,072	20,219	80,834	11.92	43 67
1913,	2,688	53,826	35,456	178,357	20.02	66 35
1914,	3,181	38,975	48,750	95,389	12.25	29 98
1915,	3,008	48,389	36,783	141,073	16.08	46 90
1916,	1,425	16,198	8,593	44,765	13.22	36 54
1917,	2,175	20,020	18,033	41,109	9.21	18 90
1918,	2,553	37,638	28,043	205,627	14.74	80 05
1919,	1,566	22,045	17,388	49,069	14.07	31 32

TYPES OF CLASSIFIED DAMAGES.

	1915.	1916.	1917.	1918.	1919.
Standing trees,	$73,782	$18,786	$24,705	$71,706	$16,595
Logs, lumber, cordwood,	23,544	4,545	4,680	37,815	7,516
Buildings,	31,904	10,823	6,893	46,025	12,508
Bridges, fences,	1,936	1,638	687	1,742	902
Not classified,	9,907	8,973	4,144	48,339	11,548
Totals,	$141,073	$44,765	$41,109	$205,627	$49,069

CLASSIFIED CAUSES OF FOREST FIRES, 1914–19.

	1914.		1915.		1916.		1917.		1918.		1919.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Unknown, ...	1,174	37.0	1,134	37.7	301	30.8	634	29.2	926	36.2	499	31.8
Railroad, ...	830	26.0	777	25.8	412	42.1	800	36.8	799	31.2	549	35.1
Burning brush, ...	196	6.2	439	14.5	79	8.1	262	12.0	300	11.7	204	13.0
Hunters, smokers, . . .	520	16.4	129	4.2	111	11.3	224	10.3	237	9.2	178	11.4
Sawmills, ...	3	.1	5	.1	2	.2	5	.2	14	.6	5	.3
Children, ...	140	4.4	161	5.3	35	3.6	133	6.1	166	6.4	61	3.9
Miscellaneous, ...	318	9.9	363	12.4	38	3.9	117	5.4	111	4.7	70	4.5
Totals, ...	3,181	100.0	3,008	100.0	978	100.0	2,175	100.0	2,553	100.0	1,566	100.0

A portion of a 300-acre plantation made by the department in Ashburnham. The trees have been set four years. Watatic Mountain is seen in the background, upon which is located one of our steel forest fire lookout stations.

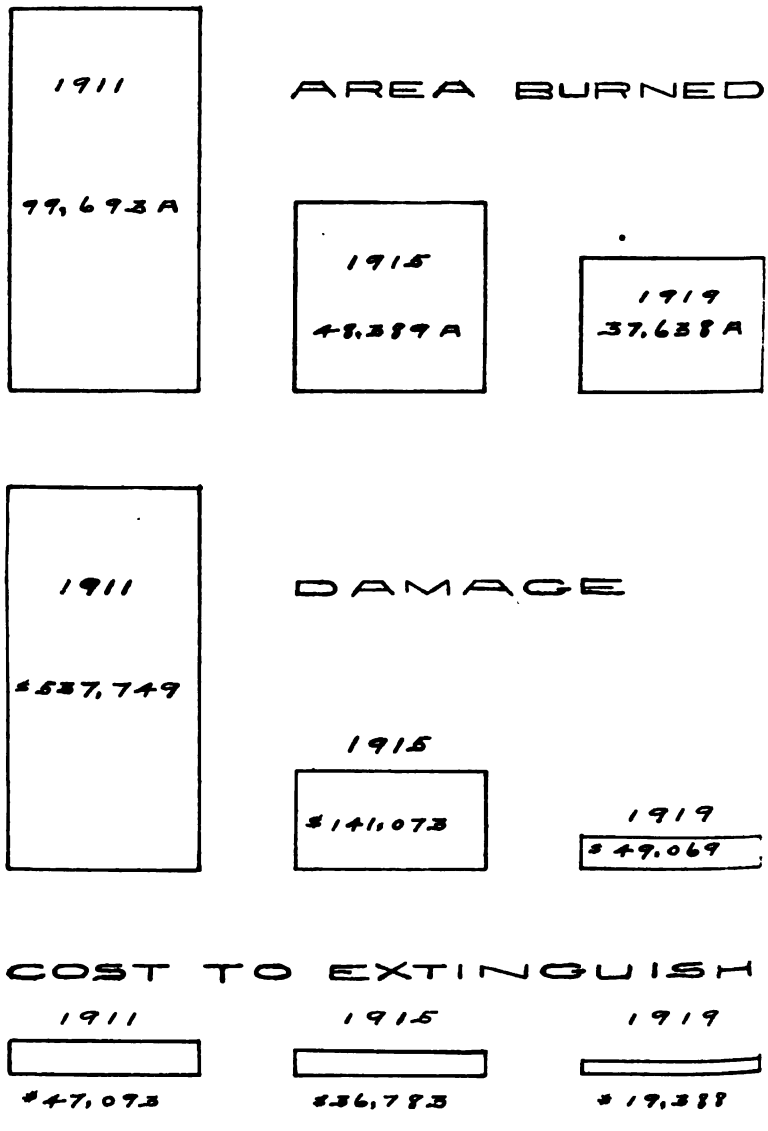
This is a large area of scrub oak land on the Cape, that has been planted with four-year transplants of white and red pine. The trees are set in the open spaces between the oak sprouts. This is believed to be the solution of reclaiming much of this waste land. In a few years the pine will overpower the oak and claim the whole area.

TYPES OF LAND BURNED OVER (ACRES).

	1915.	1916.	1917.	1918.	1919.
Timber,	3,817	1,435	1,237	2,530	1,659
Second growth,	6,749	755	2,274	5,696	2,502
Second growth, not merchantable,	9,107	1,970	4,137	6,069	2,893
Brush land,	14,681	9,990	7,126	10,549	11,122
Grass land,	8,128	1,573	3,814	4,669	3,671
Not classified,	5,907	475	1,432	8,135	198
Totals,	48,389	16,198	20,020	37,638	22,045

FOREST FIRES OF 1919.

MONTH.	Number.	Acres.	Cost to extinguish.	Damage.
1918.				
December,	9	13	$40	$5
1919.				
January,	37	104	145	-
February,	253	1,291	1,465	5,167
March,	255	3,846	2,403	5,625
April,	455	6,217	4,666	15,497
May,	302	6,658	4,804	10,890
June,	110	764	1,537	6,023
July,	77	1,273	1,616	1,784
August,	31	2,215	534	1,473
September,	6	3	28	-
October,	11	7	24	2,525
November,	20	154	126	80
Totals,	1,566	22,045	$17,388	$49,069


1911
79,693 A
AREA BURNED
1915
48,389 A
1919
37,638 A
1911
$537,749
DAMAGE
1915
$141,073
1919
$49,069
COST TO EXTINGUISH
1911
$47,073
1915
$36,783
1919
$19,388

Lectures and Addresses.

The following is a list of lectures and addresses delivered by the State Forester and his assistants during the year 1919: —

Massachusetts Tree Wardens' and Foresters' Association.
Springfield Forest Fire Conference.
Men's Club, Second Church, Dorchester.
Twentieth Century Club.
Abington Woman's Club.
Westborough Grange.
Mount Grace Reservation meeting (Warwick).
Parish House Brotherhood Club (Ipswich).
Massachusetts Fire Chiefs meeting.
Eastern Foresters' Association (Kineo, Me.).
North Shore Forestry Association (2).
Cape Cod Cranberry Association.
Society for the Protection of New Hampshire Forests (Bethlehem, N. H.)
Eastern Shook and Wooden Box Association.
State meeting of moth superintendents.
Soldiers' land public meeting (Springfield).
Society for Promotion of Agricultural Science (Baltimore, Md.).
Western New York Horticultural Society meeting.
Lawrence Chamber of Commerce.
Wholesale Dry Goods Association.
Massachusetts Agricultural Club.
New England Nurserymen's Association.
Association of Eastern Foresters (New York City).
Waltham Grange.
Northampton Chamber of Commerce.
Boston Market Gardeners' Association.
Massachusetts State Board of Agriculture.
Massachusetts Horticultural Society.
New England Forestry Congress.
Rockland Men's Club.
Marlborough Board of Trade.
Manchester citizens meeting.
Pembroke Grange.
Mayflower Pomona Grange.

State Highway Work.

The spraying of the State highways has been done as usual under the direction of this department by the local organizations in the towns or the traveling sprayers owned by the

State, and some creosoting was also done where it was deemed economical. The cost of the work was $9,991.05, and it included work in 111 municipalities.

The Distribution of Supplies.

Supplies, including arsenate of lead and hose, have been furnished to towns and cities doing gypsy-moth work, as usual. The amounts given in the list below do not always correspond exactly with the aid given the towns, as some towns make payments to the State for all or a part of the bill for supplies, according to the amount of their net expenditure or their class, under the provisions of chapter 381, Acts of 1905.

For amounts received from this office in reimbursement and for expenditures, see table on page 43.

List of Cities and Towns and Amounts of Supplies furnished for 1919.

Acton,	$825 13	Duxbury,	$1,364 41
Andover,	90	East Bridgewater,	806 83
Ashburnham,	241 03	Easton,	1,771 41
Ashby,	430 00	Essex,	301 77
Ashland,	539 70	Falmouth,	1,419 92
Avon,	163 20	Foxborough,	1,840 43
Ayer,	407 70	Freetown,	113 50
Bedford,	858 15	Georgetown,	1,103 26
Berlin,	419 64	Groton,	865 27
Billerica,	16 81	Groveland,	364 68
Bolton,	1,050 19	Halifax,	557 27
Bourne,	1,143 39	Hamilton,	757 20
Boxborough,	708 77	Hanover,	2,297 18[1]
Boxford,	686 94	Hanson,	490 99
Boylston,	354 16	Harvard,	1,334 59
Brewster,	955 61[1]	Harwich,	2,399 26[1]
Bridgewater,	1,384 13	Holbrook,	536 30
Burlington,	813 94	Holden,	1,003 47[1]
Canton,	3,761 74	Holliston,	1,229 49[1]
Carlisle,	1,331 76[1]	Hopkinton,	170 98
Carver,	2,691 50	Hudson,	6 81
Chelmsford,	887 03	Ipswich,	1,478 09
Danvers,	5 90	Kingston,	604 52
Dedham,	39 00	Lakeville,	932 83
Dennis,	260 99	Lexington,	100 36
Dover,	2,214 83	Lincoln,	2,322 17
Dracut,	1,294 27	Littleton,	887 83
Dunstable,	356 00	Lunenburg,	1,732 33

[1] This includes cost of sprayer.

LIST OF CITIES AND TOWNS AND AMOUNTS OF SUPPLIES FURNISHED FOR 1919 — *Concluded.*

Lynnfield,	$945 67	Sherborn,	$589 52
Mansfield,	16 50	Shirley,	576 22
Marion,	1,482 85	Shrewsbury,	567 47
Marshfield,	2,228 18[1]	Southborough,	1,367 45[1]
Mashpee,	1,164 69[1]	Sterling,	499 93
Medfield,	2,115 32	Stoneham,	844 31
Merrimac,	162 88	Stoughton,	1,101 47
Middleborough,	1,795 81	Stow,	861 02
Middleton,	449 21	Sudbury,	893 48
Needham,	78 00	Templeton,	251 91
Newbury,	1,128 18	Tewksbury,	905 72
Norfolk,	280 39	Topsfield,	256 87
North Andover,	1,351 09	Townsend,	585 58
North Reading,	1,282 24[1]	Truro,	174 52
Northborough,	824 22	Tyngsborough,	1,293 87
Norton,	497 43	Walpole,	78 00
Norwell,	1,058 89	Waltham,	20 04
Orleans,	921 13[1]	Wayland,	1,068 61
Pembroke,	2,260 86	Wellfleet,	411 31
Pepperell,	1,040 68	Wenham,	566 06
Plainville,	462 05	West Boylston,	521 61
Plympton,	420 14	West Bridgewater,	1,400 31[1]
Princeton,	816 20	West Newbury,	514 93
Raynham,	804 14	Westborough,	568 09
Reading,	36 94	Westford,	1,259 65
Rehoboth,	181 60	Westminster,	282 92
Rochester,	385 28	Weston,	2,189 33
Rockport,	2 58	Westport,	78 00
Rowley,	663 86	Wilmington,	1,370 16
Salisbury,	665 25	Winchendon,	460 63
Sandwich,	1,002 86	Wrentham,	11 80
Saugus,	450 00[1]	Yarmouth,	1,175 82[1]
Scituate,	2,587 54		
Sharon,	20 99		$104,965 82

[1] This includes cost of sprayer.

State Forest Commission,	$14 55
Forestry and nurseries,	2 50
Purchase and planting of forest lands,	10 80
Prevention of forest fires,	128 47
Special North Shore fund,	3,403 26
Thinning work,	50 13
Travelling sprayer,	3 15
Dover woodland work,	42 60
Massachusetts Highway Commission,	1,862 10
	$5,517 56

Financial Statements.

General Forestry and Nurseries.

Receipts.

Appropriation for 1919,		$20,850 00

Expenditures.

General: —		
Pay roll,	$4,186 00	
Travel,	4,030 84	
Printing,	193 77	
Postage, books, etc.,	22 07	
Supplies and equipment,	230 91	
Express, teaming and telephone,	227 42	
Nursery: —		
Pay roll,	9,988 70	
Seed	741 11	
Supplies and equipment,	476 09	
Express and teaming,	660 02	
Sundries,	92 35	
		20,849 28
Balance returned to treasury Nov. 30, 1919,		$0 72

Purchase and Planting of Forest Lands.

Receipts.

Appropriation for 1919,	$10,000 00

Expenditures.

Pay roll,	$8,786 30	
Travel,	202 33	
Supplies and equipment,	192 03	
Express, freight and teaming,	296 64	
Seed,	423 75	
Sundries,	82 50	
		9,983 55
Balance returned to treasury Nov. 30, 1919,		$16 45

Prevention of Forest Fires.

Receipts.

Appropriation for 1919,		$36,000 00

Expenditures.

Salaries,	$21,333 00	
Travel,	5,574 17	
Printing,	474 33	
Sundries and supplies,	344 29	
Equipment,	1,839 63	
Construction,	3,196 70	
Teams, freight and express,	89 50	
Telephone,	877 69	
Town supplies,	1,305 46	
Truck expenses,	171 10	
Rent and purchase of land,	792 00	
		35,998 73
Balance returned to treasury Nov. 30, 1919,		$1 27

Office Salaries.

Receipts.

Appropriation for 1919,	$7,300 00

Expenditures.

Salaries,	7,254 58
Balance returned to treasury Nov. 30, 1919,	$45 42

Office Incidentals.

Receipts.

Appropriation for 1919,	$5,000 00

Expenditures.

Travel,	$1,478 11	
Printing,	877 10	
Stationery and postage,	925 33	
Stationery and office supplies,	576 89	
Maps, books and photographs,	262 64	
Educational work,	52 20	
Sundries (including telephone),	375 17	
		4,547 44
Balance returned to treasury Nov. 30, 1919,		$452 56

Suppression of Gypsy and Brown-tail Moths.

Receipts.

Balance on hand Nov. 30, 1918,		$83,749 46
Less reimbursement paid for 1918,		26,262 98
Balance for 1919 work,		$57,486 48
Appropriation for 1919,		225,000 00
Receipts credited to appropriation: —		
State Forest Commission,	$21 30	
General forestry and nurseries,	26 52	
Purchase and planting of forest lands,	35 24	
Glidden Company,	760 00	
		843 06
		$283,329 54

Expenditures.

Pay roll,	$20,226 18	
Travel,	11,676 61	
Supplies,	109,435 18	
Rent of store,	300 00	
Store equipment,	134 41	
Special work,	15,874 87	
Town pay rolls,	34,710 62	
Reimbursements,	15,301 12	
Thinning work,	317 63	
Printing,	111 04	
Stationery and postage,	19 79	
Teaming, repairs, etc.,	1,542 79	
		209,650 24
Balance Nov. 30, 1919,		$73,679 30

Statement of Receipts for 1919.

General Forestry and Nurseries.

For trees sold,	$4,136 15

Purchase and Planting of Forest Lands.

Redemption and purchase of lots: —	
W. A. Wilson,	$1,275 84
Boston & Maine Railroad,	11 35
S. Bent & Brothers, Incorporated,	587 81

Caroline S. Johnson,	$166 50
Paul B. Morgan,	369 43
Lessie M. Morgan,	481 22
Levi H. Greenwood,	1,157 77
Cordwood sold: —	
French lot,	36 00
Miscellaneous: —	
Boston & Maine Railroad (damages),	26 01
Everett O. Fiske & Co.,	1 50
	$4,113 43

PREVENTION OF FOREST FIRES.

For equipment from towns and cities,	$1,597 36
For fire towers: —	
Athol,	200 00
Carlisle,	150 00
Erving,	100 00
Northfield,	100 00
Orange,	200 00
Royalston,	100 00
Warwick,	200 00
Total,	$2,647 36

SUPPRESSION OF GYPSY AND BROWN-TAIL MOTHS.

Ashby,	$84 80
Auburn,	1 45
Ayer,	984 06
Bedford,	66 96
Berkley,	25 89
Beverly,	3,000 00
Billerica,	125 15
Bourne,	311 61
Boylston,	671 20
Bridgewater,	1 02
Danvers,	4 96
Dedham,	39 00
Essex,	1,086 08
Freetown,	1 17
Groveland,	73 00
Amount carried forward,	$6,476 35

Amount brought forward,	$6,476 35
Hanson,	145 78
Holbrook,	34 73
Holden,	1,125 68
Hopkinton,	732 21
Littleton,	528 61
Lynnfield,	1,286 69
Manchester,	3,000 00
Medfield,	326 33
Medford,	80 00
Millis,	47 40
Princeton,	555 63
Quincy,	1 25
Reading,	7 02
Rehoboth,	236 14
Rockport,	3 50
Rowley,	1,113 93
Saugus,	225 00
Sharon,	2 31
Shrewsbury,	2,099 61
Stoneham,	185 91
Stoughton,	135 93
Templeton,	1,140 80
Topsfield,	497 68
Waltham,	13 36
Wayland,	561 38
Wenham,	251 08
West Boylston,	869 31
West Newbury,	77 95
Westminster,	765 05
Weston,	67 10
Winchendon,	2,574 69
Wrentham,	397 25
Yarmouth,	21 17
F. S. Goodwin,	100 00
Russell Estate,	95 00
Chautauqua Association,	13 86
Edw. R. Macomber,	20 00
F. J. Bradlee,	20 00
Wm. D. Sohier,	6,000 00
Highway Commission,	194 89
Barrels sold,	10 40
	$32,040 98

Financial Summary of Moth Work by Towns and Cities.

In the following table we show the expenditures in detail for the year 1919, and also the required expenditure for 1920: —

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Abington,	$1,499 06	–	–	–	–	–	$1,531 57
Acton,	839 31	$985 24	$753 53[1] 133 13	$155 93	$825 13	$981 06	860 43
Acushnet,	650 66	–	–	–	–	–	707 91
Amesbury,	2,936 03	–	–	–	–	–	3,011 05
Andover,	3,207 08	–	–	–	90	–	3,394 96
Arlington,	5,000 00	–	–	–	–	–	5,000 00
Ashburnham,	542 05	1,128 62	134 24	586 57	241 03	827 60	587 91
Ashby,	280 42	628 61	336 66[1]	353 19	430 00	783 19	296 00
Ashland,	651 06	848 41	218 50	197 33	539 70	737 03	689 50
Athol,	2,992 78	–	–	–	–	–	3,288 07
Attleboro,	5,000 00	–	–	–	–	–	5,000 00
Auburn,	353 20	470 81	112 56	–	–	–	365 35
Avon,	489 03	478 00	102 45	–	163 20	153 17	524 31
Ayer,	1,228 07	1,348 82	148 75	120 75	407 70	528 45	1,246 85
Barnstable,	3,407 73	–	–	–	–	–	3,693 79
Barre,	1,184 64	–	–	–	–	–	1,255 62
Bedford,	783 09	1,817 29	146 30[1] 1,111 18	1,034 20	858 15	1,892 35	828 68
Bellingham,	502 83	–	–	–	–	–	512 92
Belmont,	5,000 00	–	–	–	–	–	5,000 00
Berkley,	245 14	155 13	41 35	–	–	–	271 22
Berlin,	262 74	1,133 86	175 36	871 12	419 64	1,290 76	268 12
Beverly,	5,000 00	–	–	–	–	–	5,000 00
Billerica,	2,515 84	–	–	–	16 81	–	2,565 47
Blackstone,	808 06	–	–	–	–	–	828 87
Bolton,	322 51	1,198 55	705 00	876 04	1,050 19	1,926 23	331 89
Boston,	5,000 00	–	–	–	–	–	5,000 00
Bourne,	2,382 23	1,710 23	2,010 58	–	1,143 39	472 39	2,455 92
Boxborough,	127 43	80 98	610 23[1] 4 00	–	708 77	662 32	129 24
Boxford,	353 60	977 85	308 92	624 55	686 94	1,311 49	381 90
Boylston,	244 16	946 39	337 72	702 23	354 16	1,056 39	236 22

[1] Lead sold.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Braintree,	$3,344 14	-	-	-	-	-	$4,084 64
Brewster,	325 08	$819 26	$47 95[1] 255 28	$269 23	$955 61[2]	$999 84	324 09
Bridgewater,	1,805 40	2,050 67	5 80[1] 1,395 20	148 20	1,334 13	1,532 33	1,879 28
Brimfield,	291 68	-	-	-	-	-	341 34
Brockton,	5,000 00	-	-	-	-	-	5,000 00
Brookfield,	636 39	-	-	-	-	-	681 99
Brookline,	5,000 00	-	-	-	-	-	5,000 00
Burlington,	445 66	887 27	701 89	441 61	813 94	1,255 55	459 98
Cambridge,	5,000 00	-	-	-	-	-	5,000 00
Canton,	2,178 96	2,117 82	5,157 62	-	3,761 74	3,700 60	2,457 22
Carlisle,	201 35	2,467 11	674 81	1,990 76	1,331 76[2]	3,047 52	205 85
Carver,	796 43	2,330 71	335 86[1] 3,567 66	1,534 28	2,691 50	4,225 78	820 35
Charlton,	606 27	-	-	-	-	-	630 43
Chatham,	947 40	-	-	-	-	-	1,000 92
Chelmsford,	2,004 25	1,859 82	1,337 36	-	857 08	242 60	2,073 91
Chelsea,	5,000 00	-	-	-	-	-	5,000 00
Chilmark,	172 32	-	-	-	-	-	174 78
Clinton,	3,959 97	-	-	-	-	-	4,082 14
Cohasset,	2,461 57	-	-	-	-	-	2,619 11
Concord,	2,804 60	-	-	-	-	-	2,833 50
Dana,	194 23	-	-	-	-	-	205 95
Danvers,	3,276 13	-	-	-	5 90	-	3,301 50
Dartmouth,	2,361 12	-	-	-	-	-	2,463 10
Dedham,	5,000 00	-	-	-	39 00	-	5,000 00
Deerfield,	1,479 12	-	-	-	-	-	1,606 97
Dennis,	543 98	553 04	144 09	9 06	260 99	270 05	569 44
Dighton,	958 06	-	-	-	-	-	1,031 64
Douglas,	577 20	-	-	-	-	-	587 55
Dover,	1,067 24	1,851 28	1,520 53	777 66	2,214 53	2,992 49	1,061 53
Dracut,	1,133 53	2,039 19	846 33	900 66	1,294 27	2,194 93	1,193 56
Dudley,	997 13	-	-	-	-	-	1,133 61
Dunstable,	161 23	636 62	316 13	475 39	356 00	831 39	163 56
Duxbury,	1,355 11	2,633 11	1,633 80	1,328 00	1,304 41	1,632 41	1,366 25
East Bridgewater,	1,344 96	1,557 70	453 74	212 74	806 83	1,019 57	1,368 20
Eastham,	177 50	-	-	-	-	-	214 90

[1] Lead sold. [2] Includes sprayer.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Easthampton,	$4,242 09	–	–	–	–	–	–
Easton,	1,608 91	$1,926 92	$1,790 63	$318 01	$1,771 41	$2,098 42	$1,699 57
Edgartown,	684 33	–	–	–	–	–	702 98
Essex,	524 84	855 86	617 15	331 02	301 77	632 79	533 08
Everett,	5,000 00	–	–	–	–	–	5,000 00
Fairhaven,	2,457 19	–	–	–	–	–	2,713 65
Fall River,	5,000 00	–	–	–	–	–	5,000 00
Falmouth,	2,846 73	2,776 89	647 86	–	1,419 92	1,080 06	2,948 28
Fitchburg,	5,000 00	–	–	–	–	–	5,000 00
Foxborough,	1,191 49	2,308 90	135 87	1,117 41	1,840 48	2,957 84	1,233 88
Framingham,	5,000 00	–	–	–	–	–	5,000 00
Franklin,	2,234 46	–	–	–	–	–	2,315 95
Freetown,	517 56	–	–	–	113 50	–	549 13
Gardner,	4,556 08	–	–	–	–	–	4,766 87
Georgetown,	534 40	855 97	596 53	321 57	1,103 26	1,424 83	564 09
Gloucester,	5,000 00	–	–	–	–	–	5,000 00
Grafton,	1,396 48	815 46	100 00	–	–	–	1,423 79
Great Barrington,	3,003 13	–	–	–	–	–	3,126 96
Greenfield,	5,000 00	–	–	–	–	–	5,000 00
Groton,	1,133 98	2,024 61	440 78[1] 526 33	335 63	865 27	1,750 90	–
Groveland,	597 77	542 34	93 80[1] 585 39	–	364 68	309 25	634 83
Halifax,	311 94	1,052 38	522 38	740 44	557 27	1,297 71	325 42
Hamilton,	1,561 12	3,098 58	1,370 51	600 00	757 20	1,357 20	1,608 59
Hanover,	777 13	2,099 94	1,699 11	1,097 81	2,297 18[2]	3,169 99	830 19
Hanson,	824 01	1,014 96	592 71	190 95	490 99	681 94	805 56
Harvard,	771 45	992 68	367 36[1] 947 41	221 23	1,334 59	1,555 82	648 24
Harwich,	779 48	3,060 75	616 06	1,831 27	2,399 26[2]	3,780 53	797 64
Haverhill,	5,000 00	–	–	–	–	–	5,000 00
Hingham,	2,811 67	–	–	–	–	–	2,895 96
Holbrook,	739 00	542 22	407 60	–	536 30	339 62	793 69
Holden,	828 56	2,207 74	449 25	1,379 18	1,003 47[2]	2,157 65	1,010 27
Holliston,	840 67	1,203 05	80 33[1] 532 42	–	1,354 49[2]	916 87	855 52
Hopedale,	1,709 00	–	–	–	–	–	1,713 95
Hopkinton,	751 74	1,376 34	53 70	624 60	170 96	795 58	778 62
Hubbardston,	336 19	–	–	–	–	–	352 53

[1] Lead sold.

[2] Includes sprayer.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Hudson,	$1,882 75	$1,711 49	$12 75[1] 664 51	–	$6 81	–	$2,084 97
Hull,	4,284 04	–	–	–	–	–	4,403 74
Ipswich,	2,254 91	2,249 89	1,658 05	–	1,478 09	$1,478 09	2,282 06
Kingston,	658 63	1,116 11	321 72	$457 48	604 52	1,062 00	674 82
Lakeville,	490 01	472 92	516 47	–	982 83	915 74	497 27
Lancaster,	963 67	–	–	–	–	–	995 43
Lawrence,	5,000 00	–	–	–	–	–	5,000 00
Leicester,	1,072 55	–	–	–	–	–	1,091 39
Lenox,	2,961 12	–	–	–	–	–	2,953 58
Leominster,	5,000 00	–	–	–	–	–	5,000 00
Lexington,	3,410 94	6,908 12	17 05[3] 1,657 18	–	100 36	100 36	3,586 70
Leyden,	108 19	–	–	–	–	–	110 27
Lincoln,	751 37	1,896 36	1,252 76	–	2,322 17	2,322 17	767 42
Littleton,	536 99	453 41	600 91[1] 45 75	–	887 23	804 25	560 69
Lowell,	5,000 00	–	–	–	–	–	5,000 00
Lunenburg,	683 59	1,201 30	370 25[1] 7,780 07	202 56	1,723 33[2]	1,519 74	710 59
Lynn,	5,000 00	–	–	–	–	–	5,000 00
Lynnfield,	646 99	1,544 17	630 89	397 18	945 67	1,842 85	668 55
Malden,	5,000 00	–	–	–	–	–	5,000 00
Manchester,	4,468 66	–	–	–	–	–	4,502 21
Mansfield,	2,128 25	–	–	–	16 50	–	2,248 21
Marblehead,	4,642 13	–	–	–	–	–	4,658 24
Marion,	1,305 77	1,460 48	1,156 62	–	1,482 85	1,482 85	1,316 29
Marlborough,	4,683 77	–	–	–	–	–	4,775 83
Marshfield,	1,097 80	1,364 56	128 08[1] 1,763 14	41 76	2,228 18[2]	2,044 94	1,103 27
Mashpee,	186 18	2,307 37	661 25	1,896 59	1,164 69[2]	2,836 28	193 51
Mattapoisett	744 37	–	–	–	–	–	768 47
Maynard,	1,819 15	–	–	–	–	–	1,928 70
Medfield,	858 25	1,038 08	42 84[1] 371 37	179 83	2,115 32	2,296 15	861 32
Medford,	5,000 00	–	–	–	–	–	5,000 00
Medway,	770 78	–	–	–	–	–	812 91
Melrose,	5,000 00	–	–	–	–	–	5,000 00
Mendon,	304 37	–	–	–	–	–	309 91
Merrimac,	651 71	1,172 75	207 55	521 04	162 88	683 92	662 96
Methuen,	5,000 00	–	–	–	–	–	5,000 00

[1] Lead sold. [2] Includes sprayer. [3] Supplies sold.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Middleborough,	$2,013 95	$3,054 11	$1,028 90	$1,040 16	$1,795 81	-	$2,104 62
Middleton,	401 84	1,272 14	328 52	870 30	449 21	$1,319 51	407 44
Milford,	4,194 49	-	-	-	-	-	4,250 30
Millbury,	1,404 94	-	-	-	-	-	1,483 50
Millis,	640 73	-	-	-	-	-	690 58
Millville,	501 66	-	-	-	-	-	515 79
Milton,	5,000 00	-	-	-	-	-	5,000 00
Monson,	868 76	-	-	-	-	-	826 42
Montague,	3,423 75	-	-	-	-	-	3,592 79
Nahant,	1,653 67	-	-	-	-	-	1,652 74
Nantucket,	2,202 52	-	-	-	-	-	2,223 16
Natick,	3,402 99	-	-	-	-	-	3,588 46
Needham,	3,351 44	-	-	-	78 00	-	3,960 63
New Bedford,	5,000 00	-	-	-	-	-	5,000 00
New Braintree,	188 95	-	-	-	-	-	193 12
New Salem,	222 07	-	-	-	-	-	216 12
Newbury,	603 38	1,699 18	433 27[1] 583 30	1,096 80	1,128 18	2,223 98	629 10
Newburyport,	4,582 32	-	-	-	-	-	4,690 38
Newton,	5,000 00	-	-	-	-	-	5,000 00
Norfolk,	482 04	817 20	240 90	335 16	280 39	615 55	499 67
North Andover,	2,364 66	3,016 92	269 50[1] 1,430 70	-	1,351 09	1,351 09	2,429 85
No. Attleborough,	3,332 90	-	-	-	-	-	3,423 81
North Brookfield,	832 08	-	-	-	-	-	860 17
North Reading,	453 16	1,765 72	589 26	1,037 56	1,282 24[2]	2,044 80	463 97
Northborough,	773 89	1,831 98	676 99	1,058 09	824 22	1,883 31	778 43
Northbridge,	2,134 13	-	-	-	-	-	2,236 20
Norton,	721 70	1,036 93	159 38	315 23	497 43	812 66	777 91
Norwell,	505 65	1,070 40	139 90[1] 2,070 62	564 75	1,058 89	1,623 64	515 29
Norwood,	5,000 00	-	-	-	-	-	5,000 00
Oak Bluffs,	905 45	-	-	-	-	-	-
Oakham,	181 85	-	-	-	-	-	173 40
Orange,	1,652 96	-	-	-	-	-	1,748 65
Orleans,	529 73	1,053 74	291 75	299 01	921 13[2]	995 14	531 68
Oxford,	856 09	-	-	-	-	-	941 56
Palmer,	2,756 51	-	-	-	-	-	2,841 65

[1] Lead sold.

[2] Includes sprayer.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Paxton,	$170 91	–	–	–	–	–	$169 77
Peabody,	5,000 00	–	–	–	–	–	5,000 00
Pembroke,	541 89	$2,831 24	$1,431 21	$2,299 45	$2,260 86	$4,550 31	551 66
Pepperell,	1,017 64	2,877 20	100 90[1]; 593 10	1,316 08	1,040 68	2,356 76	1,021 54
Petersham,	428 76	–	–	–	–	–	446 59
Phillipston,	135 88	–	–	–	–	–	136 61
Plainville,	446 83	791 86	63 70	345 03	462 05	807 08	–
Plymouth,	5,000 00	–	–	–	–	–	5,000 00
Plympton,	196 55	1,556 53	12 00[1]; 131 82	1,359 98	420 14	1,780 12	207 03
Princeton,	447 82	2,228 41	196 04	1,780 59	816 20	2,596 79	452 54
Provincetown,	1,264 48	–	–	–	–	–	1,255 58
Quincy,	5,000 00	–	–	–	–	–	5,000 00
Randolph,	1,121 36	–	–	–	–	–	1,161 62
Raynham,	506 25	520 98	335 01	–	804 14	804 14	536 22
Reading,	3,233 19	–	–	–	36 94	–	3,277 45
Rehoboth,	471 23	–	–	–	181 60	–	471 94
Revere,	5,000 00	–	–	–	–	–	5,000 00
Rochester,	436 95	602 19	278 10	165 24	385 28	550 52	452 87
Rockland,	2,168 15	–	–	–	–	–	2,277 72
Rockport,	1,732 93	–	–	–	2 58	–	1,772 64
Rowley,	405 24	1,616 82	185 70[1]; 476 02	1,211 58	663 86	1,875 44	413 22
Royalston,	357 73	–	–	–	–	–	330 60
Rutland,	400 93	–	–	–	–	–	421 15
Salem,	5,000 00	–	–	–	–	–	5,000 00
Salisbury,	783 06	1,124 22	76 57[1]; 398 40	341 16	665 25	1,006 41	811 89
Sandwich,	575 71	1,056 59	256 97[1]; 172 32	430 88	1,002 86	1,433 74	586 67
Saugus,	3,127 06	–	–	–	450 00[2]	–	3,206 92
Scituate,	2,473 49	2,919 14	26 84[1]; 2,669 40	–	2,587 54	2,426 75	2,533 41
Seekonk,	850 77	–	–	–	–	–	979 34
Sharon,	1,409 18	–	–	–	20 99	–	1,442 26
Sherborn,	643 83	2,235 22	594 90[1]; 990 57	1,591 39	589 52	2,180 91	669 14
Shirley,	574 76	613 23	62 00[1]; 199 00	–	576 22	576 22	654 29
Shrewsbury,	1,453 30	2,044 66	924 76	591 36	567 47	1,158 83	1,658 05
Somerset,	811 68	–	–	–	–	–	997 17
Somerville,	5,000 00	–	–	–	–	–	5,000 00

[1] Lead sold.

[2] Includes sprayer.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Southborough,	$878 43	$2,027 24	$1,096 20	$923 76	$1,367 45[2]	$2,066 21	$893 45
Spencer,	1,424 03	–	–	–	–	–	1,458 37
Springfield,	5,000 00	–	–	–	–	–	5,000 00
Sterling,	556 27	915 12	186 96[1] / 87 70	358 85	499 93	858 78	579 03
Stockbridge,	1,804 38	–	–	–	–	–	1,879 94
Stoneham,	2,613 96	2,613 96	986 58	–	844 31	675 75	2,975 59
Stoughton,	2,254 84	2,441 60	10 80[1] / 949 60	186 76	1,101 47	1,288 23	2,400 19
Stow,	456 71	1,881 26	837 73	1,424 55	861 02	2,285 57	462 51
Sturbridge,	399 88	–	–	–	–	–	428 93
Sudbury,	574 06	1,125 69	925 36[1] / 374 65	551 63	893 48	1,445 11	580 10
Sutton,	650 46	–	–	–	–	–	665 65
Swampscott,	5,000 00	–	–	–	–	–	5,000 00
Swansea,	731 06	–	–	–	–	–	772 03
Taunton,	5,000 00	–	–	–	–	–	5,000 00
Templeton,	1,021 79	1,244 50	220 70	222 71	251 91	474 62	–
Tewksbury,	1,112 63	2,298 30	548 84	1,185 67	905 72	2,091 39	1,099 64
Tisbury,	839 40	–	–	–	–	–	866 55
Topsfield,	377 39	854 46	277 11	–	256 87	233 94	943 41
Townsend,	563 69	1,476 99	799 95	913 30	585 58	1,498 88	569 79
Truro,	222 85	381 96	67 65	159 11	174 52	333 63	253 08
Tyngsborough,	369 37	3,345 95	1,245 47	2,975 58	1,293 87	4,269 45	374 33
Upton,	565 98	–	–	–	–	–	546 86
Uxbridge,	1,743 96	–	–	–	–	–	1,971 59
Wakefield,	5,000 00	–	–	–	–	–	5,000 00
Walpole,	2,965 19	–	–	–	78 00	–	2,964 11
Waltham,	5,000 00	–	–	–	20 04	–	5,000 00
Ware,	2,467 70	–	–	–	–	–	2,519 09
Wareham,	2,520 54	–	–	–	–	–	2,733 90
Warren,	1,073 46	–	–	–	–	–	1,180 40
Warwick,	181 87	–	–	–	–	–	181 97
Watertown,	5,000 00	–	–	–	–	–	5,000 00
Wayland,	968 88	363 35	693 65[1] / 755 45	–	1,068 61	463 08	–
Webster,	2,573 86	–	–	–	–	–	2,685 05
Wellesley,	5,000 00	–	–	–	–	–	5,000 00
Wellfleet,	323 57	659 02	141 85	335 45	411 31	746 76	332 37

[1] Lead sold.

[2] Includes sprayer.

Cities and Towns.	1919.						1920.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Wendell,	$236 90	–	–	–	–	–	$275 24
Wenham,	890 26	$450 87	$370 43	–	$566 06	$126 67	906 25
West Boylston,	442 91	753 74	343 35	$310 88	521 61	832 44	452 68
West Bridgewater,	757 85	2,131 50	600 91	1,148 65	1,400 31[2]	2,323 96	793 08
West Newbury,	407 98	489 91	131 70[1] 342 16	81 93	514 93	596 86	416 02
West Tisbury,	226 09	–	–	–	–	–	228 49
Westborough,	1,341 81	1,998 52	784 51	656 71	568 09	1,224 80	1,361 57
Westford,	958 83	1,171 09	369 00[1] 515 21	212 26	1,259 65	1,471 91	994 99
Westminster,	403 89	941 24	299 04	537 35	282 92	820 27	465 59
Weston,	2,012 96	2,518 91	920 00	505 95	2,189 23	–	2,054 91
Westport,	1,234 39	–	–	–	78 00	–	1,239 29
Westwood,	1,061 71	–	–	–	–	–	1,026 17
Weymouth,	5,000 00	–	–	–	–	–	5,000 00
Whitman,	2,282 27	–	–	–	–	–	2,339 37
Wilmington,	879 46	2,375 80	761 20	1,496 34	1,370 16	2,866 50	888 55
Winchendon,	1,813 99	2,741 49	812 50	927 50	460 63	1,388 13	1,857 80
Winchester,	5,000 00	–	–	–	–	–	5,000 00
Winthrop,	5,000 00	–	–	–	–	–	5,000 00
Woburn,	5,000 00	–	–	–	–	–	5,000 00
Worcester,	5,000 00	–	–	–	–	–	5,000 00
Wrentham,	699 86	–	–	–	11 80	–	728 94
Yarmouth,	760 41	935 12	17 52[1] 467 29	174 71	1,175 82[2]	1,125 53	788 52

[1] Lead sold. [2] Includes sprayer.

List of Forest Wardens and Local Moth Superintendents.

[Alphabetically by towns and cities.]

Telephone Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
157-W, Rockland,	Sumner L. Deane,	Abington,	C. F. Shaw,	5
71-4, West Acton,	Wm. H. Kingsley,	Acton,	J. O'Neil,	2
2003-M,	Henry F. Taber,	Acushnet,	A. P. R. Gilmore,	4
121-X,	Edgar A. Deyette,	Adams,	John Clancy,	6
6465-M, River,	E. M. Hitchcock,	Agawam,	E. M. Hitchcock,	6
161-6,	W. F. Milligan,	Alford,	- -	-
274-M,	Jas. E. Feltham,	Amesbury,	Joseph Merrill,	3
483-J,	A. F. Bardwell,	Amherst,	W. H. Smith,	6
212,	Lester Hilton,	Andover,	Edw. H. Berry,	3
35 and 206,	Daniel M. Daley,	Arlington,	Daniel M. Daley,	2
5-12,	C. H. Billings,	Ashburnham,	Chas. H. Pratt,	2
2-3,	W. S. Green,	Ashby,	Fred C. Allen,	2
3-5,	Ralph Tredick,	Ashfield,	Chas. A. Smith,	6
- -	Chester W. McNear,	Ashland,	Theodore P. Hall,	2
18-3,	Frank P. Hall,	Athol,	W. S. Penniman,	6
34-R-4,	H. R. Packard,	Attleboro,	W. E. S. Smith,	4
5-12,	J. F. Searle,	Auburn,	J. F. Searle,	6
- -	Chas. S. Wheeler,	Avon,	W. W. Beals,	4
306-3,	D. C. Smith,	Ayer,	D. C. Smith,	2
144-2,	H. C. Bacon,	Barnstable,	Robert Cross,	5
83-4,	A. E. Traver,	Barre,	Jas. A. Dwinnell,	6
18 and 8000,	P. B. McCormack,	Becket,	- -	-
498-W, Lexington,	Irving C. Waite,	Bedford,	W. A. Cutler,	3
62-4,	John J. Fairchild,	Belchertown,	E. C. Howard,	6
8639-2, Milford,	L. F. Thayer,	Bellingham,	Lewis E. Whitney,	4
409-W,	John F. Leonard,	Belmont,	Martin Troy,	2
1267-M,	Gideon H. Babbitt,	Berkley,	A. A. Briggs,	4
17-2,	Forrest E. Day,	Berlin,	E. C. Ross,	2
43-12,	Edson W. Hale,	Bernardston,	Edwin B. Hale,	6
20 and 95-0,	R. H. Grant,	Beverly,	Jas. W. Blackmer,	1
22-4 and 22-5,	E. N. Bartlett,	Billerica,	Fred L. Winship,	3
- -	John H. Dwyer,	Blackstone,	A. J. Duggan,	6
16-3,	I. E. Whitney,	Blandford,	- -	-
3-3,	Albert I. Pardee,	Bolton,	C. E. Mace,	2
- -	- -	Boston,	Wm. P. Long,	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
38, . . .	Walter E. R. Nye, .	Bourne, . .	Edw. D. Nickerson, .	5
102-2, . . .	H. J. Livermore, .	Boxborough, .	S. D. Salmon, 3d, .	2
19-31, . . .	C. E. Brown, . .	Boxford, . .	C. Perley, . . .	3
29-2, . . .	John N. Flagg, . .	Boylston, . .	Walter G. Brigham, .	6
– –	James M. Cutting, .	Braintree, . .	Clarence R. Bestick, .	4
76-23, . . .	T. B. Tubman, . .	Brewster, . .	Abbott N. Baker, .	5
281-13, . . .	F. C. Worthen, . .	Bridgewater, .	F. C. Worthen, . .	5
18-2, . . .	Geo. E. Hitchcock, .	Brimfield, . .	Frank G. Hitchcock, .	6
1041, . . .	Wm. F. Daley, . .	Brockton, . .	Rufus H. Carr, . .	5
104-11, . .	P. E. Gadaire, . .	Brookfield, . .	J. H. Conant, . .	6
– –	Geo. H. Johnson, .	Brookline, . .	Ernest B. Dane, .	1
52-8, . . .	Gilbert E. Griswold, .	Buckland, . .	– –	–
15-4, . . .	W. W. Skelton, . .	Burlington, .	W. W. Skelton, . .	3
– –	– –	Cambridge, .	J. F. Donnelly, . .	2
– –	C. J. Callahan, . .	Canton, . .	Wm. H. Gallivan, .	4
76-M, Concord, .	Geo. G. Wilkins, .	Carlisle, . .	Geo. G. Wilkins, .	3
– –	Jas. S. McKay, . .	Carver, . .	James S. McKay, .	5
14-12, . . .	A. L. Veber, . .	Charlemont, .	– –	–
42-2, . . .	E. A. Lamb, . .	Charlton, . .	J. D. Fellows, . .	6
28-3, . . .	Geo. W. Ryder, . .	Chatham, . .	Richard G. Luard, .	5
1597-R, . .	A. C. Perham, . .	Chelmsford, .	Walter Shepard, .	3
– –	– –	Chelsea, . .	J. A. O'Brien, . .	1
– –	Warren E. Brown, .	Cheshire, . .	– –	–
– –	Wm. H. Babb, . .	Chester, . .	– –	–
4-2, . . .	Chas. Bisbee, . .	Chesterfield, .	– –	–
149-M, . .	John E. Pomphret, .	Chicopee, . .	Edw. Bourbeau, .	6
– –	Almon S. Tilton, .	Chilmark, . .	Almon S. Tilton, .	5
485-X, . .	A. G. Caswell, . .	Clarksburg, .	A. G. Caswell, . .	6
268-W and 180, .	Adin W. Custance, .	Clinton, . .	Peter R. Gibbons, .	2
260, . . .	Wm. J. Brennock, .	Cohasset, . .	George Young, . .	5
23-2, . . .	F. A. Walden, . .	Colrain, . .	E. F. Copeland, .	6
72 and 458-M, .	Harry E. Tuttle, .	Concord, . .	H. P. Richardson, .	2
15-2, . . .	Edgar Jones, . .	Conway, . .	– –	–
41-2, . . .	Wm. H. Mansell, .	Cummington, .	– –	–
86-W, . . .	S. L. Caesar, . .	Dalton, . .	– –	–
– –	L. H. Thayer, . .	Dana, . . .	Thos. L. Thayer, .	6
495-W, . .	Wm. E. Berry, . .	Danvers, . .	T. E. Tinsley, . .	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
1658-5 New Bedford.	C. H. Mead,	Dartmouth,	E. M. Munson,	4
35-R,	H. J. Harrigan,	Dedham,	J. T. Kennedy,	4
– –	Wm. L. Harris,	Deerfield,	Wm. L. Harris,	6
3118-4,	Wm. E. Pierce,	Dennis,	Joshua Crowell,	5
29-3,	Ralph Earle,	Dighton,	Albert N. Goff,	4
11-4,	W. L. Church,	Douglas,	F. J. Libby,	6
– –	Geo. W. Armstrong,	Dover,	H. L. MacKenzie,	4
– –	F. H. Gunther,	Dracut,	T. F. Carrick,	3
423-R, Webster,	Frank A. Putnam,	Dudley,	Herbert J. Hill,	6
9-11, Tyngsborough.	A. W. Swallow,	Dunstable,	W. H. Savill,	2
82-2,	H. E. Merry,	Duxbury,	John D. Morrison,	5
68-2,	M. F. Roach,	E. Bridgewater,	Allan B. Shaw,	5
25,	F. C. Burton,	E. Longmeadow,	Herman W. King,	6
24-3,	Adin L. Gill,	Eastham,	N. P. Clark,	5
306-12,	John M. Dineen,	Easthampton,	Chas. Kuhfuss,	6
76 and 67,	Fred Hanlon,	Easton,	Roscoe W. Melendy,	4
– –	Manuel Roberts,	Edgartown,	John P. Fuller,	5
165-25,	Frank Bradford,	Egremont,	H. C. Moore,	6
31-2,	Clinton Powell,	Enfield,	C. H. Holmes,	6
– –	C. H. Holmes,	Erving,	C. H. Holmes,	6
51-3,	Otis O. Story,	Essex,	Otis O. Story,	1
– –	– –	Everett,	Dana Hanson,	2
1686-Y,	C. F. Benson,	Fairhaven,	G. W. King,	4
822-W,	Wm. Stevenson,	Fall River,	Wm. Stevenson,	4
136-2,	H. H. Lawrence,	Falmouth,	W. W. Eldridge, Jr.,	5
745,	Guy A. Hubbard,	Fitchburg,	Guy A. Hubbard,	2
9417-3, Hoosac Tunnel pay station.	H. B. Brown,	Florida,	– –	–
76 and 121,	Ernest A. White,	Foxborough,	C. W. Parkhurst,	4
352-4,	B. P. Winch,	Framingham,	N. I. Bowditch,	2
66-12,	E. S. Cook,	Franklin,	J. W. Stobart,	4
7-3,	Oscar M. Hanson,	Freetown,	G. M. Nichols,	4
191 and 161,	G. S. Hodgman,	Gardner,	Chas. J. Crabtree,	6
85-14,	N. B. Madison,	Gay Head,	N. B. Madison,	5
71-12 and 8046-2,	Thos. A. Watson,	Georgetown,	Jacob Hasen,	3
222-12,	Lewis C. Munn,	Gill,	Warren R. Purple,	6
1043-M,	Geo. W. O'Maley,	Gloucester,	Harland W. Dann,	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
– –	Frank L. Rice, . .	Goshen, . .	– –	–
– –	F. A. Veeder, . .	Gosnold, . .	– –	–
18-2, . . .	E. E. Sibley, . .	Grafton, . .	C. K. Despeau, .	6
– –	Charles Rust, . .	Granby, . .	George A. Harris, .	6
5-13, . . .	Albert C. Sheets, .	Granville, . .	– –	–
327-W, . .	D. W. Flynn, . .	Great Barrington.	Daniel W. Flynn, .	6
1185, . . .	John W. Bragg, . .	Greenfield, . .	John W. Bragg, . .	6
33-24, . . .	Wm. H. Walker, . .	Greenwich, .	Thos. Severance, Jr.,	6
71-5, . . .	C. M. Raddin, . .	Groton, . .	Shadrach Evans, .	2
3655-X, . .	S. E. Johnson, . .	Groveland, . .	R. D. Larive, . .	2
651-33, . .	Edw. P. West, . .	Hadley, . .	Leroy C. Sabin, .	6
106-7, Bridgewater,	D. M. Briggs, . .	Halifax, . .	John A. Wood, . .	5
6-2, . . .	Fred Berry, . .	Hamilton, . .	Harry R. McGregor, .	1
– –	John Swenson, . .	Hampden, . .	– –	–
17-F-2, . .	C. F. Tucker, . .	Hancock, . .	– –	–
441-Y, Rockland,	Louis E. Stone, .	Hanover, . .	Chas. B. Drew, .	5
12-23, Bryantville,	George T. Moore, .	Hanson, . .	George T. Moore, .	5
43-12, . . .	George J. Fay, . .	Hardwick, . .	George J. Fay, . .	6
63-3, . . .	Geo. C. Maynard, .	Harvard, . .	Geo. C. Maynard, .	2
103-3, . . .	John Condon, . .	Harwich, . .	Arthur F. Cahoon, .	5
72-4, . . .	Fred T. Bardwell, .	Hatfield, . .	Seth W. Kingsley, .	6
4-1, . . .	John B. Gordon, .	Haverhill, . .	M. J. Fitzgerald, .	3
17-7, . . .	Herbert A. Holden, .	Hawley, . .	– –	–
5-13, . . .	S. G. Benson, . .	Heath, . .	– –	–
570 and 344-M, .	Wm. L. Howard, .	Hingham, . .	T. L. Murphy, .	5
33-12, . . .	Alfred N. Warren, .	Hinsdale, . .	– –	–
297-M, . .	M. L. Coulter, . .	Holbrook, . .	Walter C. Belcher, .	4
42-4, . . .	W. H. Stearns, . .	Holden, . .	Winfred H. Stearns, .	6
5-21, Brimfield, .	Oliver L. Howlett, .	Holland, . .	W. A. Morse, . .	6
113, . . .	Waldo A. Collins, .	Holliston, . .	Herbert E. Jones, .	2
1167-W, . .	C. J. Haley, . .	Holyoke, . .	T. A. Bray, . .	6
248-W, . .	S. E. Kellogg, . .	Hopedale, . .	C. E. Nutting, . .	6
19, . . .	Geo. W. Smith, . .	Hopkinton, .	W. A. MacMillan, .	6
8040 and 24-4, .	Albert E. Bennett, .	Hubbardston, .	Chas. P. Wyman, .	6
24, . . .	M. P. Mitchell, . .	Hudson, . .	T. J. Higgins, . .	2
– –	– –	Hull, . . .	John F. Smith, . .	5
4-11, . . .	John J. Kirby, . .	Huntington, .	– –	–

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
137-W,	Edw. H. Smith,	Ipswich,	J. A. Morey,	1
108,	Roland Bailey,	Kingston,	Chas. H. Childs,	5
261-W,	N. F. Washburn,	Lakeville,	N. F. Washburn,	5
218-J,	A. W. Blood,	Lancaster,	L. R. Griswold,	2
1295-24,	King D. Keeler,	Lanesborough,	King D. Keeler,	6
362 and 3610,	F. J. Morris,	Lawrence,	John H. Brown,	3
66-M,	Jas. W. Bossidy,	Lee,	– –	–
35-5,	John A. Fitzpatrick,	Leicester,	J. H. Woodhead,	6
60 and 135,	O. R. Hutchinson,	Lenox,	T. Francis Mackey,	6
28, 29 and 546,	F. A. Russell,	Leominster,	D. E. Bassett,	2
9-25,	Fred L. Morrison,	Leverett,	I. H. Taylor,	6
480,	Osborne J. Gorman,	Lexington,	Osborne J. Gorman,	3
284-41,	A. G. Parks,	Leyden,	A. G. Parks,	6
44-W,	John J. Kelliher,	Lincoln,	John J. Kelliher,	2
17-4,	A. E. Hopkins,	Littleton,	A. E. Hopkins,	2
6375-J, River,	Oscar C. Pomeroy,	Longmeadow,	– –	–
3400,	Edw. F. Saunders,	Lowell,	J. G. Gordon,	3
1-12,	H. A. Munsing,	Ludlow,	Ashley N. Bucher,	6
20,	J. S. Gilchrest,	Lunenburg,	J. S. Gilchrest,	2
1174 and 5613-J,	D. J. Dineen,	Lynn,	John P. Morrissey,	1
3682-M,	F. C. Newhall,	Lynnfield,	L. H. Twiss,	1
– –	W. B. Gould,	Malden,	Watson B. Gould,	2
319-W,	Peter A. Sheahan,	Manchester,	Peter A. Sheahan,	1
281-W, 1-R and 1-W.	Herbert E. King,	Mansfield,	Alexander Murphy,	4
355,	John T. Adams,	Marblehead,	W. H. Stevens,	1
117-2,	George B. Nye,	Marion,	J. Allenach,	5
– –	Edw. C. Minehan,	Marlborough,	M. E. Lyons,	2
42-3,	Wm. G. Ford,	Marshfield,	P. R. Livermore,	5
31-2, Cotuit,	Darius Coombs,	Mashpee,	S. H. Peters,	5
53-5,	Chas. T. Dexter,	Mattapoisett,	Jas. A. Barlow,	5
115-4 and 72,	Geo. H. Gutteredge,	Maynard,	John F. Cleary,	2
108-3,	Lawrence M. Dewar,	Medfield,	G. L. L. Allen,	4
138,	Thomas A. Qualey,	Medford,	Hugh G. Kennedy,	2
6-2,	John B. Durfee,	Medway,	F. Hagar,	4
– –	– –	Melrose,	J. J. McCullough,	3
– –	Carl M. Taft,	Mendon,	F. M. Aldrich,	6
3-5,	Chas. R. Ford,	Merrimac,	Chas. R. Ford,	3

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
– –	Geo. E. Douglas,	Methuen,	A. H. Wagland,	3
76-Y,	John J. Fowler, Jr.,	Middleborough,	John J. Fowler, Jr.,	5
8000,	Geo. E. Cook,	Middlefield,	– –	–
63-23,	Oscar H. Sheldon,	Middleton,	B. T. McGlauflin,	1
37-M,	E. J. Burke,	Milford,	P. F. Fitzgerald,	6
259,	Harry L. Snelling,	Millbury,	E. F. Roach,	6
73,	Chas. LaCroix,	Millis,	Ralph L. Choate,	4
1149-J, Woonsocket, R. I.	R. M. McLaughlin,	Millville,	Patrick Britt,	6
1022-W,	Ralph S. Carpenter,	Milton,	Ralph S. Carpenter,	4
13-13, Readsboro, Vt.	Edward C. Davis,	Monroe,	– –	–
12-22,	O. E. Bradway,	Monson,	Robert S. Fay,	6
14-14,	Thomas Berard,	Montague,	F. B. Gillette,	6
164-25,	Jasper H. Bills,	Monterey,	– –	–
3-24,	Andrew J. Hall,	Montgomery,	– –	–
17-6,	Howard Porter,	Mount Washington.	– –	–
16-3,	E. W. Francis,	Nahant,	Herbert Coles,	1
16-3,	E. W. Francis,	Nantucket,	W. M. Voorneveld,	5
31 and 248-W,	Wm. H. Connolly,	Natick,	S. H. Hunnewell,	2
142,	H. Howard Upham,	Needham,	George Twigg,	4
– –	Chas. S. Baker,	New Ashford,	– –	–
2280,	Edw. F. Dahill,	New Bedford,	C. F. Lawton,	4
6-4, Gilbertville,	Frank A. Morse,	New Braintree,	E. L. Havens,	6
13-6,	E. M. Stanton,	New Marlborough.	– –	–
113-5,	Frank Hamilton,	New Salem,	Frank Hamilton,	6
1112-5,	Wm. P. Bailey,	Newbury,	Percy Oliver,	3
380,	Chas. P. Kelley,	Newburyport,	Chas. P. Kelley,	3
30, Newton South.	W. B. Randlett,	Newton,	Chas. Benyon,	2
41-13, Franklin,	S. C. Watson,	Norfolk,	J. Albert Buckley,	4
265 and 205-W,	H. J. Montgomery,	North Adams,	Jackson L. Temple,	6
1029-J,	Wm. L. Smith,	North Andover,	Wm. L. Smith,	3
282-W and 317-R-1,	H. W. Tufts,	North Attleborough.	F. P. Toner,	4
63-4,	Oscar C. Hirbour,	North Brookfield	S. B. Colburn,	6
49,	George E. Eaton,	North Reading,	George E. Eaton,	3
165,	F. E. Chase,	Northampton,	Chas. A. Maynard,	6
12-11,	C. E. Bailey,	Northborough,	Harry Ellsworth,	6
71-5 and 182, Whitinsville.	W. E. Burnap,	Northbridge,	A. F. Whitin,	6
114-2,	Fred W. Doane,	Northfield,	F. W. Doane,	6

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
18-11,	Geo. H. Storer,	Norton,	Wm. G. Briggs, Jr.,	4
15-3,	John T. Osborne,	Norwell,	Fred M. Curtis,	5
417-M,	F. W. Talbot,	Norwood,	Wm. P. Hammersley,	4
241-12,	Geo. A. Smith,	Oak Bluffs,	Frank F. Blankenship.	5
17-5,	C. H. Trowbridge,	Oakham,	C. H. Trowbridge,	6
232-12,	Wm. Walsh,	Orange,	Elbridge S. Blodgett,	6
33-2,	James Boland,	Orleans,	A. Smith,	5
11-5,	George A. Barton,	Otis,	– –	–
9-5,	Olin D. Vickers,	Oxford,	C. G. Larned,	6
53-W and 53-R,	James Summers,	Palmer,	C. H. Keith,	6
1255-W Cedar,	Geo. W. VanWyck, Jr.,	Paxton,	H. S. Robinson,	6
213-M,	John J. Callahan,	Peabody,	J. J. Callahan,	1
5-W,	John H. Hubbard,	Pelham,	Leigh Weaver,	6
83-3 Bryantville, 3015-4 Hanover.	Jos. J. Shepherd,	Pembroke,	Wm. C. Jones,	5
23-21,	Grant M. Palmer,	Pepperell,	J. Tune,	2
– –	Walter H. Pike,	Peru,	– –	–
61,	George Marsh,	Petersham,	Daniel Broderick,	6
176-6,	Wm. H. Cowlbeck,	Phillipston,	Wm. H. Cowlbeck,	6
834 and 535-M,	Chas. S. Klein,	Pittsfield,	– –	–
17-6,	E. H. Nye,	Plainfield,	– –	–
– –	Henry A. Boerger,	Plainville,	George H. Snell,	4
264,	Ira C. Ward,	Plymouth,	A. A. Raymond,	5
13-7, Kingston	David L. Bricknell,	Plympton,	David L. Bricknell,	5
19-4, Cooleyville,	Fred W. Doubleday,	Prescott,	C. M. Pierce,	6
13-4,	Fred W. Bryant,	Princeton,	F. A. Skinner,	6
159-11,	Jas. H. Barnett,	Provincetown,	F. G. Hill,	5
1,	Faxon T. Billings,	Quincy,	A. J. Stewart,	4
134-W,	F. Burt Jasuith,	Randolph,	Chas. H. Cole,	4
1161-W,	E. E. Chickering,	Raynham,	G. M. Leach,	4
430,	O. O. Ordway,	Reading,	H. M. Donegan,	3
11-12,	B. F. Munroe,	Rehoboth,	Chas. B. Douglas,	4
– –	– –	Revere,	G. P. Babson,	1
8-2,	T. B. Salmon,	Richmond,	– –	–
12-32,	D. E. Hartley,	Rochester,	Samuel H. Corse,	5
55-X,	John H. Burke,	Rockland,	F. H. Shaw,	5
14-4,	John C. Martin,	Rockport,	F. A. Babcock,	1
22-6,	Merritt Peck,	Rowe,	– –	–

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3-13, . . .	Daniel O'Brien, . .	Rowley, . .	Chas. Curtis, . .	3
177-5, Athol, .	M. E. Stockwell, .	Royalston, . .	E. S. Stewart, . .	6
11-3, . . .	S. S. Shurtleff, . .	Russell, . .	- -	-
13-4, . . .	H. E. Wheeler, . .	Rutland, . .	H. E. Wheeler, . .	6
- -	- -	Salem, . . .	Wm. F. Cotter, . .	1
123-13, . .	Jas. H. Pike, . .	Salisbury, . .	Chas. J. Penniman, .	3
202-3, . . .	S. D. Strickland, . .	Sandisfield, .	- -	-
76-2, . . .	J. R. Holway, . .	Sandwich, . .	Lincoln Crowell, .	5
346-W, . .	T. E. Berrett, . .	Saugus, . .	T. E. Berrett, . .	1
4-16, . . .	C. E. Tilton, . .	Savoy, . . .	- -	-
129-3, . . .	E. R. Seaverns, . .	Scituate, . .	Wm. F. Ford, . .	5
462-J-2, Pawtucket.	Herbert S. Baker, .	Seekonk, . .	C. A. Smith, . .	4
10 and 43-5, .	W. C. Morse, . .	Sharon, . .	Fred A. White, . .	4
75, . . .	C. H. Warner, . .	Sheffield, . .	- -	-
130-2, . . .	Chas. F. Dole, . .	Shelburne, . .	Chas. F. Dole, . .	6
- -	John C. Jackson, .	Sherborn, . .	Geo. W. Rock, . .	2
- -	Asa A. Adams, . .	Shirley, . .	Asa A. Adams, . .	2
- -	Edw. A. Logan, . .	Shrewsbury, .	Robt. C. Clapp, .	6
- -	C. N. Mellen, . .	Shutesbury, .	E. Colfax Johnson, .	6
923-M, . .	F. B. Butterworth, .	Somerset, . .	C. Riley, . . .	4
- -	- -	Somerville, . .	A. B. Prichard, .	2
22, Holyoke, .	Louis H. Lamb, . .	South Hadley, .	Louis H. Lamb, .	6
151-14, . .	W. J. Lyman, . .	Southampton, .	- -	-
13, Marlborough, 3505, Fort Hill.	Harry Burnett, . .	Southborough, .	Harry Burnett, . .	6
11, . . .	Aimee Langevin, .	Southbridge, .	Aimee Langevin, .	6
35-3, . . .	B. M. Hastings, . .	Southwick, .	- -	-
134-3, . . .	Earl J. Potter, . .	Spencer, . .	G. Ramer, . .	-
20 and 167-2, Orchard.	F. C. Smith, . .	Springfield, .	L. Fletcher Prouty, .	6
5-12, . . .	Joel T. Wilder, . .	Sterling, . .	J. H. Kilburn, . .	2
53-M, . . .	George Schneyer, .	Stockbridge, .	George Schneyer, .	6
176-W, . .	Albert J. Smith, . .	Stoneham, . .	G. M. Jefts, . .	3
218-2 and 121-3, .	Fred H. Pye, . .	Stoughton, .	W. P. Kennedy, .	4
166-11, Hudson, .	Harold A. Priest, .	Stow, . . .	H. W. Herrick, . .	2
6-1, . . .	C. M. Clark, . .	Sturbridge, .	C. M. Clark, . .	6
5-4, . . .	Seneca W. Hall, . .	Sudbury, . .	Chas. A. Brackett, .	2
46, South Deerfield.	A. C. Warner, . .	Sunderland, .	Richard Graves, .	6
58-4, Millbury, .	R. H. Richardson, .	Sutton, . .	R. H. Richardson, .	6

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
1911-J,	Everett P. Mudge,	Swampscott,	Everett P. Mudge,	1
468-W,	Thos. L. Mason,	Swansea,	A. E. Arnold,	4
1 and 320,	Fred A. Leonard,	Taunton,	H. M. Briggs,	4
39 and 30,	C. A. Fletcher,	Templeton,	J. B. Wheeler,	6
4249-J,	Harris M. Briggs,	Tewksbury,	H. M. Briggs,	3
161-4 and 102-3,	Elmer C. Chadwick,	Tisbury,	H. W. McLellan,	5
269-16,	Rupert E. Clark,	Tolland,	- -	-
36-6,	Wayland Burnham,	Topsfield,	Wayland E. Burnham,	1
14-4,	Mark R. Colby,	Townsend,	G. E. King,	2
- -	Walter F. Rich,	Truro,	J. H. Atwood,	5
25-12,	Chas. J. Allgrove,	Tyngsborough,	C. J. Allgrove,	3
278-3,	Geo. R. Warren,	Tyringham,	- -	-
9-3,	Henry E. Allard,	Upton,	Clarence L. Goodrich,	6
- -	Lewis F. Maroney,	Uxbridge,	Willard Holbrook,	6
59 and 548-M,	W. E. Cade,	Wakefield,	W. W. Whittredge,	3
9-11 and 9-23,	L. H. Thompson,	Wales,	M. C. Royce,	6
107-2,	Jas. J. Hennessey,	Walpole,	Phillip R. Allen,	2
6,	George L. Johnson,	Waltham,	W. M. Ryan,	2
- -	Alfred H. Pigeon,	Ware,	F. Zeissig,	6
187,	James J. Walsh,	Wareham,	J. J. Walsh,	5
- -	T. M. Collins,	Warren,	Alex. A. Gendron,	6
73-12,	C. A. Williams,	Warwick,	Chas. Bass,	6
12-4, Becket,	Arthur L. Hayes,	Washington,	- -	-
116, Newton South.	Van D. Horton,	Watertown,	Van D. Horton,	2
31-3,	Howard C. Haynes,	Wayland,	D. J. Graham,	2
101-R,	E. L. Wallis,	Webster,	C. Klebart,	6
9,	John P. Doyle,	Wellesley,	Thos. T. Watt,	4
- -	John Holbrook,	Wellfleet,	Wm. H. Gill,	5
6-13, Cooleyville,	C. A. Fiske,	Wendell,	G. E. Mills,	6
74,	Jacob D. Barnes,	Wenham,	J. E. Kavanagh,	1
36,	Harry E. Lowe,	West Boylston,	Harry E. Lowe,	6
- -	W. P. Laughton,	W. Bridgewater,	O. Belmore,	5
114-3,	John H. Webb,	W. Brookfield,	John H. Webb,	6
35-11,	Chas. W. Barnes,	West Newbury,	Frank D. Bailey,	3
6961-J and 1504,	Elam B. Jones,	W. Springfield,	George W. Hayden,	6
3010,	B. P. Bissell,	W. Stockbridge,	- -	-
92-3,	Wm. J. Rotch,	West Tisbury,	Jerry B. Mayhew,	5

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
153-12,	T. W. Humphrey,	Westborough,	George E. Hayden,	6
111-Y,	T. H. Mahoney,	Westfield,	– –	–
44-11,	H. L. Nesmith,	Westford,	H. L. Nesmith,	3
1482-2, Easthampton.	Myron L. Clapp,	Westhampton,	– –	–
1-3,	W. F. Neal,	Westminster,	G. A. Sargent,	6
1329-M,	B. R. Parker,	Weston,	E. P. Ripley,	2
41-21,	Frank Whalon,	Westport,	Christopher Borden,	4
302-W, Dedham,	Elmer E. Smith,	Westwood,	Martin Sorenson,	4
185-M,	Walter W. Pratt,	Weymouth,	C. L. Merritt,	4
– –	Thos. J. Flynn,	Whately,	Rylan C. Howes,	6
349-W,	C. A. Randall,	Whitman,	C. A. Randall,	5
1-4,	Henry I. Edson,	Wilbraham,	Henry I. Edson,	6
8011-2,	John Brown,	Williamsburg,	– –	–
329-W,	Wm. H. Davies,	Williamstown,	Wm. H. Davies,	6
19-2,	Edwin L. Day,	Wilmington,	Oliver McGrane,	3
102-4,	Theron C. Flint,	Winchendon,	Waldo F. Streeter,	6
4 and 39,	David H. DeCourcy,	Winchester,	S. S. Symmes,	3
202-12,	Amos S. Ferry,	Windsor,	– –	–
– –	– –	Winthrop,	Harry Hills,	1
– –	Frank E. Tracey,	Woburn,	H. V. Macksey,	3
7137, Park,	W. N. Avery,	Worcester,	Thos. E. Holland,	6
10-22,	Chas. A. Kilbourn,	Worthington,	– –	–
21-5 and 69,	Geo. H. E. Mayshaw,	Wrentham,	H. Gilmore,	4
53-31,	J. W. Hamblin,	Yarmouth,	Sidney T. Holway,	5

RECOMMENDATIONS.

1. That the present law governing the disposal of slash or brush needs revision in such a way as to place the responsibility for getting the results desired.

2. That there should be a law prescribing the manner of measuring wood when it is sold in short lengths other than 3 and 4 foot lengths, and sold as thrown wood (not piled) or cubic measure.

3. That provision be made through the enactment of law for extending financial aid to certain towns in the extinguishing of forest fires.

Respectfully submitted,

F. W. RANE,
State Forester.

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

REFORESTATION IN MASSACHUSETTS.

INTRODUCTION.

The first bulletin issued from this department on the subject of reforestation was published in 1910 by R. S. Langdell, assistant to State Forester Rane. This bulletin becoming quickly exhausted, a second edition with slight additions was offered in 1913. Only a few copies of the second edition now remain.

The present edition is undertaken for the purpose of bringing our experience and practice up to date, after having observed during the last ten years the trees grown in experimental plantations and the effects produced by soil and location in different parts of the State.

While experiments are still in progress we have come to pin our faith more and more to the cone-bearing species, to the elimination of deciduous trees. We must develop a forest that shall be as nearly as possible gypsy-moth proof, as well as immune to destructive disease. To this end we have recommended in the following pages only the trees that, up to the present time, have stood the test.

Inasmuch as the average landowner is more interested in the actual reclaiming of the land than in nursery practice, less space has been devoted in the present bulletin to the forest nursery, and greater emphasis is placed on the handling of young trees in the plantation. To those wishing to establish a forest nursery we recommend government Bulletin No. 76, which may be obtained for a small sum by writing to the Superintendent of Documents, Washington, D. C. The bulletin in hand will give the general principles of this phase of the work, but is intended primarily for those who have purchased nursery stock from the Commonwealth, or from some of the many reliable nursery firms doing business throughout the State.

SYLVICULTURAL CHARACTERISTICS OF TREES RECOMMENDED FOR PLANTING IN MASSACHUSETTS.

White Pine (*Pinus strobus*). — This species is placed first, both because of its marked adaptability to growth in this State and because of the universal demand for its lumber. It is but fair to say that the white pine blister rust offers some menace to clear plantations of this species, especially in Berkshire and Essex counties; but by making mixed plantings, and by eradicating currant and gooseberry bushes in the vicinity, white pine may be relied on to do its part in the conquest of the waste-land problem. Even the two-needle pines suffer from another species of blister rust (the alternate host being sweet-fern), and the owner must expect to lose a few specimens of whatever species he may use through disease, insects, winter-killing or dry weather. The present system of planting provides for more trees than are ultimately necessary on each acre of ground, as well as for thinning, both natural and artificial. A plantation in which white pine represents the *expectation crop*, but in which enough trees of other varieties have been planted to provide for any emergency, is, in our judgment, the practical and ideal undertaking.[1]

The white pine may be found growing in all sorts of situations except in extremely wet soil. This does not mean that the tree grows equally well everywhere, for it undoubtedly prefers well-drained loamy sand, and there reaches its best development. Ideal conditions exist on the slopes and at the bottoms of old glacial deposits, so numerous all over the State.

Reproduction is by seed, which is produced at intervals of from three to seven years, called "seed years."

As regards size and rate of growth, white pine compares favorably with any of our eastern trees, and far exceeds most of them in these respects, reaching the best merchantable size in about fifty years. If left to grow undisturbed it reaches a size excelled only by trees of the Pacific coast, specimens having been

[1] Many of our lumbermen and most of our nurserymen, from their observations and experience, are still of the opinion that they will continue to plant white pine in pure stands as well as in mixed. Likewise, from correspondence and consultation with many of our leading plant pathologists and foresters as to diagnosing the future results of the white pine blister rust, the prevailing impression is that the presence of this disease does not warrant undue fear or exaggeration, or the abandonment of the white pine for reforestation purposes.

FIG. 1. — Four-year white pine transplant.

FIG. 2. — Four-year red pine transplant.

recorded that exceed 200 feet in height, with a diameter of 6 feet, while heights of 100 feet, with 3-foot diameters, are not uncommon.

The chief enemy of the pine forests in this State is fire, which, if it does not kill the trees, so weakens them as to render them liable to attack by several kinds of insects and fungi. The white pine is especially susceptible when young, even a slight ground fire being quite sufficient to completely kill it.

The leading insect enemies are the white pine weevil and the pine aphis. The weevil attacks the main shoot, and in some cases greatly damages young trees up to the age of ten or twelve years. Infested shoots should be pruned and burned during the summer months. The aphis is a small sap-sucking insect, and seldom does permanent damage. A simple spray will easily control it in the event that it appears in large numbers on a small area or on individual trees.

The gypsy moth, while it will eat pines as well as nearly every other kind of tree, does not invade pure stands containing pine alone. The brown-tail moth does not feed on pine.

The many uses of white pine are well known. Among them may be mentioned building timber of all kinds, laths, cabinet material, interior finish, woodenware, matches, flag poles, masts and boxes.

Red or Norway Pine (*Pinus resinosa*). — This tree, while common in northern New England, is not very familiar to residents of Massachusetts. It does not grow in pure stands, but usually in scattered groups with other conifers and hardwoods. The difficulty of collecting the seed in this locality renders the cost of raising the seedlings and transplants very high. Red pine, however, is a very excellent species, and compares favorably with white pine in many respects. It is more nearly immune from the blister rust of two-needle pines than any other member of that group, and represents a safe investment when planted in a favorable location. It prefers a dry sandy loam, outstripping the white pine on gravelly ridges, and will thrive in dry, rocky land. It should never be planted in the swamps or on poorly drained land. In rate of growth the red pine is more rapid than the white when young, though it is shorter-lived in the long run. It reaches a height of 70 to 80 feet,

with trunk diameter of 2 to 3 feet, and in old age develops an open, round-topped, picturesque head. The wood is light, hard, close-grained, pale red, with thin yellow sapwood. The lumber is largely used in construction of bridges and buildings, and for piles, masts and spars. For many purposes the lumber is mixed with that of white pine, and the two varieties are not distinguished.

Scotch Pine (*Pinus sylvestris*). — The Scotch pine is the common pine of northern Europe, occupying there the same place that the white pine does in this country as a timber tree. Its growth more resembles our red pine, both in quality of lumber and in the kind of soil preferred by the tree. In common with other pines, Scotch is not much subject to disease and insect attack, but is somewhat more sensitive to fire than red pine. Scotch pine is used for the same purposes as red pine.

Austrian Pine (*Pinus Austriaca*, Endl.) — The Austrian pine has been used successfully in this State in experimental plantations, and is recommended as a substitute for, or in mixture with, Scotch and red pine. It grows on a sandy soil and is a tree of very beautiful appearance, having long and heavy needles. It should not be used for underplanting except where the woods are open, or where heavy thinnings have been made.

Hemlock (*Tsuga americana*). — The hemlock, one of the most tolerant (shade-enduring) of the American conifers, prefers cold north and east slopes of the hillsides. Because of its ability to thrive even in dense shade, it will grow as an understory with other species, evergreen or hardwood, or in pure stands in all stages of growth.

The wood is being more and more used for building timber as the supply of other species grows scarcer, and some dealers prefer it to spruce for rough frame timbers. If care is not used in drying, it is likely to check.

Norway Spruce (*Picea excelsa*). — This is one of the principal timber trees of Europe, and is strongly recommended for planting in this country, possessing, as it does, all of the advantages of our native red spruce, with the added one of being a much more rapid grower. Our experience is that Norway spruce suffers much less from winterkill than pine, and recovers remarkably after suppression by hardwoods. It is especially de-

FIG. 3. — Four-year Scotch pine transplant.

FIG. 4. — Evolution of a four-year white pine transplant. Seedling shown in upper left-nand corner is one year old.

sirable for underplanting in hardwood stands, a good combination being spruce and hemlock.

Red Spruce (*Picea rubra*). — This tree is the timber spruce of the northeast, and is now the most important species in New England in size of cut. It will grow in northern Massachusetts on the higher elevations, preferably in mixture with pine and hemlock. It will grow in the shade of other trees for many years, and shows marked recuperative ability when suddenly exposed to the light.

Growth is not rapid, and large size is not reached by this species; but good straight timber is produced, which finds a ready market. The limbs persist, as in the case of white pine, and the best clear timber is grown in mixed stands.

The tree reproduces itself well when the leaf litter on the ground is not too thick, and seedlings start readily under the mature trees of the same species, forming a stand containing trees of all ages.

The uses of the wood are well known, — building timber, piano sounding-boards, inside finish, clapboards and pulp-wood.

American Larch (*Larix laricina*) *and European Larch* (*Larix decidua*, Mill). — The American larch, also known as tamarack and hackmatack, is the only native deciduous conifer in Massachusetts. In winter, after the needles have been shed, it presents the appearance of a dead tree. It bears little resemblance to any of our native conifers, but closely resembles the European larch (*Larix decidua*, Mill), which may be distinguished by its larger cones, stouter twigs and more abundant leaves. The European larch is the more rapid grower, and will thrive in a less moist and less fertile soil than the native species. Larch should be planted in mixture with other trees, among which are recommended spruce, balsam, fir and hemlock. The principal uses are ship and boat timber, telegraph poles, fence posts and railroad ties.

Balsam Fir (*Abies balsamea*). — This tree is of small commercial importance in Massachusetts, but is recommended for certain areas where other more valuable species are hard to propagate, notably in swampy land, and for use in underplanting. It is sometimes planted in mixture and thinned out later for Christmas trees. Tolerance and comparative freedom from

insects and disease are arguments in its favor. Experimental plantations made by this department several years ago demonstrate that the balsam fir, like the Norway and red spruce, will hold out under a considerable amount of shade, and resume normal growth when released.

THE FOREST NURSERY.

The forest nursery represents the first step in the work of land reclamation. Seed-plots were at one time a favorite experiment among farmers and landowners, and plantations are in existence that were started in this way. But nature is prodigal in her waste of seed, and it was early discovered that by gathering and planting this waste seed in beds a high percentage could be germinated and brought to an age adaptable to low-cost reforestation. A three-year or four-year transplant may be used in grass or brush land where seed would not have one chance in a thousand.

Procuring the Seed.

The cone-bearing trees differ from the hardwoods in the matter of bearing seed, usually devoting a few years to preparation for a large crop. Our native white pine produces an abundant crop every five to seven years, and bears its seed in cones or burrs, which generally grow in clusters of twos or threes on the upper branches of the tree. There are two seeds at the base of each scale of the cone.

All coniferous seed should be gathered from the trees before the cone-scales have opened. The cones should be spread out on a smooth floor in the sun, raked over from time to time, and finally flayed until the seed has been completely threshed out. This should then be cleaned by winnowing, and kept in bags in a cool dry place, out of the reach of birds and mice. If properly stored the seed in most cases retains its vitality for a number of years.

FIG. 5.—Pine cones spread out to dry, in order that seed may be extracted.

FIG. 6.—A bed 12 by 4 feet, containing about 10,000 one-year white pine seedlings.

Raising Transplants from Seed.

Level or gently sloping well-drained land should be selected for a nursery, the soil being preferably a sandy loam, free from stones. Any length of bed is practicable, but the most convenient width is 4 to 6 feet, with walks 2 feet wide between the beds. The seed is planted in drills or broadcast, according to whether it is desired to leave the seedlings in the bed two years or three years before transplanting. The system that has proved most efficient in our nursery practice in Massachusetts is the construction of 12 by 4 foot beds, with a frame made of lath and fine-mesh chicken wire. The lath gives the young seedlings the proper proportion of light and shade, and the fine-mesh wire protects both seed and seedlings from mice and birds. A burlap cover is used for shading in place of leaves until the seed germinates and appears through the soil, at the end of which time the burlap may be removed for a portion of each day, and finally dispensed with, rolled up and stored for the following season.

A bed 12 by 4 feet takes approximately three-quarters of a pound of seed and produces from 5,000 to 15,000 seedlings, according to the kind of seed used and the success with which they are germinated. Seed may be planted in April or May, but it is usually more convenient to wait until June, when the season for digging transplants is over and more time can be devoted to the work of seeding and care of the new crop.

The seed germinates in about three weeks' time and makes its first year's growth within a couple of months. The seedlings are usually left in the original bed for two years, then transplanted into longer beds and spaced from 1½ to 2 inches apart to prevent crowding. They remain here for two years more, and are then ready for permanent planting on waste land.

A tree so planted is called a four-year transplant, and is the ideal tree for use in reforestation. In old pastures, where the grass is short and there is no great quantity of brush, the two-year seedling may be used with success.

REFORESTATION.

How Trees should be planted.

Heeling in.

When trees have been properly handled at the nursery they will arrive in good condition, packed in damp moss and tied in bundles of 25, 50 or 100, depending on the size and species. Scotch and Austrian pine are more bulky, as a rule, than white pine and spruce. The trees should be heeled in as soon as possible after their arrival. This requires the digging of a trench about 1 foot wide and 1 foot deep, and laid out as nearly as possible east and west. If only a few trees are involved in the shipment, and planting can be accomplished in a few hours' time, no trench will be necessary. It is advisable to first cover the roots with a light layer of earth, pour on a few pails of water, and then cover thoroughly with earth, leaving the tops exposed to light and air. Care should be taken not to cover any portion of the needles with earth, and in the event of dry weather the trees should be watered daily. A covering of burlap or paper will protect them from excessive heat, and will hold back the buds until the trees can be planted. One thousand trees require a trench about 12 feet long.

Requirements for Planting.

We have experimented with various kinds of planting instruments, such as planting irons, bars, spades, etc., and find that the grub-hoe, or mattock, is the most practical instrument for all kinds of soil. Some of our foremen prefer the double-headed mattock, which on one side resembles an axe, and on the other an adz. The axe is used for cutting out a square hole in the sod or leaf-mold approximately 1 foot square, and the adz-like edge for lifting out the earth to a depth of 6 to 8 inches. The average man prefers the single-bladed adz-like mattock, similar to the one shown in Figs. 8 and 9. The most efficient crew consists of two men, one to make the holes and the other to do the planting. The trees are carried in a pail, which should be kept about half full of a mixture of water and

FIG. 7.—Two-man planting crew at work.

FIG. 8. — First step in making the hole.

FIG. 9. — Second step in making the hole.

FIG. 10. — Setting the seedling and covering the roots.

FIG. 11. — Firming the soil by pressure of the foot.

loam. The bundles should be untied before placing them in the pail. Sod should not be replaced, and each tree should be firmly set by pressing the earth about it with the foot. An experienced two-man crew can plant from 800 to 1,000 trees per day.

Spacing.

The best practice is to space the trees 6 feet apart each way. This method produces a tall, straight bole and prevents undue spreading. Flags may be set up at the end of the field as a guide to the crews, and moved over 6 feet as the end of the course is reached.

On moist situations Norway spruce or balsam fir may be planted alternately with white pine. If the pine is set 6 by 6 feet, and the fir or spruce set in the centers of the squares thus formed, the trees will be evenly spaced 3 feet apart. In from eight to ten years the fir and spruce will yield an incidental revenue if cut and sold as Christmas trees. It has the added advantage of rendering a plantation comparatively safe from any local disease or insect attack that may seriously deplete any one of the species used. And in this connection it may be said that the forest planter would do well to use at least two species of trees, even in the 6-foot spacing. When planting pine the combination recommended is white pine, alternated with red, Scotch or Austrian pine. Spruce may be alternated with hemlock, tamarack or balsam fir.

Number of Trees required per Acre.

Spacing.	Trees.
3 by 3 feet,	4,840
4 by 4 feet,	2,722
5 by 5 feet,	1,742
6 by 6 feet,	1,210
7 by 7 feet,	888
8 by 8 feet,	680
10 by 10 feet,	435

Time to plant.

Planting should be undertaken as soon as the frost is out of the ground in the spring, the months of April and May being preferable, in order that the young roots may get started before the dry season sets in. Spring planting is preferable to fall planting, as the roots having started will not be as likely to be heaved out by the frost; although under certain conditions fall planting is sometimes resorted to, as in a case where a piece of land is too wet to work in the spring, but becomes dry during the summer and fall. The time for fall planting depends largely on the season. The months of September and October are usually best in this State.

Care of the Young Plantation.

An ideal plantation requires very little care until it is old enough to be thinned, which under ordinary conditions would be at about the twentieth year; but preparation against possible disappointment and failure is as necessary in the matter of trees as in the raising of an agricultural crop, and weed-trees choke out a plantation in much the same way that witch-grass chokes out grain.

With the exception of old fields, described on another page, waste land will, in a short space of time, develop hardwood sprouts of questionable value; and even the old fields will occasionally reproduce unexpected crops of gray birch and popple seedlings, to the great detriment of the planted pine.

Most plantations must, therefore, be brushed over, in order that the young pine shall not be shaded out before it has "topped" the less valuable species growing around it. Nature has provided that, in the long run, the conifers will win in the struggle for supremacy, on account of longevity and general good health. But the struggle may last for centuries. The desired result can be obtained in less time through the medium of proper assistance on the part of man. The amount of cost will depend on whether the hardwood brush is simply lopped and left on the ground, or whether it is piled and burned. The latter is the better and safer method, but where the fire hazard is negligible the former is recommended.

FIG. 12. — White pine transplants that were set in the open spaces among scrub oak following a forest fire. The small trees were four years old when set three years ago, and have grown on an average of from 1 to 2 feet each year during the past two years. They will undoubtedly overcome the oak.

Species most easily controlled.

Gray birch and popple, while abundantly prolific, do not cast a dense shade. Where these trees persist, money can be saved by liberal use of the bush scythe on portions of the lot where these trees are abnormally thick. Scattered birch and popple in the young plantation will often do good by supplying a light shade during summer, by rubbing off the lateral branches of the pine, and by helping to develop a long, straight leading shoot. In many cases it is advantageous to go over the plantation with a pair of pruning shears, snipping only the lateral branches of the hardwoods that interfere with the topmost branches of the pine. This method saves expense and develops good pine lumber.

Another species that may be classed under this head is oak, which, while it casts a very dense shade, is slow-growing and may be surpassed in height by the pine, provided the latter is given a reasonable amount of assistance. Where oak alone is involved, one thorough brushing will often meet the requirements, and the pine will gain the ascendency. The better grades of oak may be handled by "limbing up." Scrub oak is an inferior species and should be cut clean. Scrub oak following a fire may sometimes be crowded out in the course of time by planting the pine in the open spaces. This applies especially to certain portions of Cape Cod and Martha's Vineyard. (See Fig. 12.)

Species Difficult of Control.

The trees most difficult of control in the young plantation are the chestnut and the soft maple, on account of their very rapid growth. The chestnut bark disease cannot be depended upon to kill off sufficient sprouts to protect the pine, as sprouts will continue to spring up so long as there is any life in the old stump. Maple is equally fast growing, has no destructive enemies, and casts a dense shade. Repeated brushing is the only protection for a pine plantation made among maple sprouts.

Suggestion for making a Pine Plantation among Dense Hardwood Sprouts.

When pine is greatly desired on land offering strong resistance by reason of its dense hardwood sprout growth, cuttings may be made about 12 to 15 feet apart, and the pines planted in these paths with the usual spacing. It is of course necessary to keep the area on which the pine is planted free from brush. In time a mixed stand will result, composed of protected pine and the best specimens of the prevailing natural hardwoods, in parallel sections. The State Department of Forestry has not undertaken this practice on any large scale, but recommends it on the basis of experiments thus far made.

Another good method which has been tried with success on several of our reforested lots is as follows: with a bush scythe or bill hook cut all hardwood sprouts around each pine over a space about 5 feet in diameter. This allows the pine to keep its main shoot free to the light, and results in a good mixed stand of pine and hardwood.

Fire Lines.

In event of undue fire hazard a good means of protection is to make a fire line around the plantation on the side where the greatest danger lies. This is done by cutting the brush and clearing the ground of all inflammable material on a strip about 50 feet wide. Warning notices may be obtained by application to the State Forester. The fire line is not practicable unless it is kept clean, but when cared for it often proves a vantage point from which destructive fires approaching from a distant area may be turned back and ordinary brush fires may be easily managed.

Types of Land Suitable for Reforestation.

The total area of Massachusetts is about 5,321,787 acres, of which 2,672,950 acres is land adapted only to the growing of trees. Of this area there are about 700,000 acres which at the present time constitute practically worthless tracts, being simply a tax to the owners, who at a very small outlay could bring

the land back into profitable forest growth, as well as add to the scenic beauty of the section.

This land lies in tracts varying in size from one to thousands of acres. Practically every farm has a portion which at one time or another has been cut off, burnt over or allowed to lapse into a condition where it is no longer a source of revenue, — a piece of property which brings in no return, though it is still taxable. Lumbermen, mill owners, water-right companies and farmers all have some land which falls under one of the following types, and it is this sort of land which, fortunately, furnishes ideal conditions for forest planting.

Cut-over Land.

Undoubtedly every lumberman in the Commonwealth owns one or more tracts of land which he has cut off, but which has not come back into any profitable growth and which gives no promise of a future crop.

Where the land cut off was previously growing pine it is not always advisable to reforest it the first or second season following, on account of the damage that is almost sure to result from the pine stump beetle (*Hylobius pales*). This beetle breeds in the bark of recently cut pine stumps, but dies out as the bark decays. It chews the bark of young conifers, girdling and sometimes killing them, and damages the lateral branches of larger growth.

Where the land cut off was previously growing hardwoods it is advisable to reforest as soon as possible, as the sprout and hardwood growths, if allowed to gain too great a headway, will hold the transplants in check, and expensive brushing will become necessary. In some cases hardwood sprouts are so persistent as to make reforestation a doubtful investment. Where doubt exists as to the advisability of planting such land, an application should be made to the State Forester for an examination.

Burned Land.

On land which has been subjected to repeated fires, destroying the growth and ground cover, the soil is left free to the action of the weather, to be quickly dried out by the sun, or,

if on a side hill, to be washed into the valley by rains. The seed or seedlings which may have been on the ground have been destroyed, and the land might lie for a long period of years before it would reseed itself naturally. Land of this type, therefore, should be set with considerable care, in order to obtain the best results. It is generally advisable to set a four-year-old transplant here rather than seedlings.

Run-out Fields.

Many of the farms throughout the State have been allowed to decline, and are growing up to brush and undesirable hardwoods. Pasture lands especially are being encroached upon by some of our less valuable trees, such as chokecherry and gray birch, which so overshade the ground that good pasturage runs out, and the lot is abandoned for fields affording better forage. In many cases scattering white pines have crept in, and probably in time would seed in the whole piece; but the advanced growth, while doing good work in reseeding, would be of little value, as, growing so scattered, they would develop large lateral branches instead of giving a clear, straight bole so desirable in the best grade of lumber. If the lot could be set out with seedlings, and the trees allowed to grow in sufficiently dense stands, the lower branches would die off naturally, and smooth, clear lumber would be assured.

Underplanting in Thinned Stands.

Where woodland has been extensively thinned to eliminate undesirable species, or for the purpose of marketing the mature timber, underplanting is practicable and advisable. For this purpose a tolerant (shade-enduring) tree is necessary, and among the best species may be named the Norway spruce, the hemlock, the tamarack and the balsam fir. They should be planted in the open spaces as much as possible, or in such a way that they may not grow into the branches of other trees. Otherwise they must be released in a few years' time by cutting the older growth, and damage will result from felling.

FIG. 13.—A thinned stand of hickory. Ready for *underplanting* with spruce or hemlock, or with pine in the more open spaces.

Reforestation Work done by the State.

Under "An Act to provide for the purchase of forest land and for reforestation," passed by the Legislature of 1908, provision is made whereby private landowners may deed tracts of land suitable for reforestation purposes to the State, to be planted and handled under practical forest management, such owners reserving the right to redeem the land at any time within ten years for the actual amount expended. Provision is also made for the distribution of seeds and seedlings at not less than cost to landowners who are citizens of the Commonwealth.

The State has now acquired over 150 tracts of land under this act, comprising in all about 6,000 acres. The number of trees required in planting these areas, and in supplying the State institutions, the Metropolitan Water Board, the cities, the towns and the schools, has been so great that few, if any, have been left over for the private landowner until the present year. During the spring of 1918, however, we distributed at cost more than 500,000 four-year transplants of white and Scotch pine to citizens in all parts of the State. The price charged for these trees was $7 per 1,000, representing the actual cost of raising them in our nurseries.

Acts of 1908, Chapter 478.

Reforestation Act.

Section 1. For the purpose of experiment and illustration in forest management, and for the purposes specified in section five of this act, the sum of five thousand dollars may be expended in the year nineteen hundred and eight, and the sum of ten thousand dollars annually thereafter, by the state forester, with the advice and consent of the governor and council, in purchasing lands situated within the commonwealth and adapted to forest production. The price of such land shall not exceed in any instance five dollars per acre, nor shall more than eighty acres be acquired in any one tract in any one year, except that a greater area may so be acquired if the land purchased directly affects a source or tributary of water supply in any city or town of the commonwealth. All lands acquired under the provisions of this act shall be conveyed to the commonwealth, and no lands shall be paid for, nor shall any moneys be expended in improvements thereon, until all instruments of conveyance and the

title to be transferred thereby have been approved by the attorney-general, and until such instruments have been executed and recorded.

SECTION 2. The owners of land purchased under this act, or their heirs and assigns, may repurchase the land from the commonwealth at any time within ten years after the purchase by the commonwealth, upon paying the price originally paid by the commonwealth, together with the amount expended in improvements and maintenance, with interest at the rate of four per cent per annum on the purchase price. The state forester, with the approval of the governor and council, may execute in behalf of the commonwealth such deeds of reconveyance as may be necessary under this section: *provided, however,* that there shall be included in such deeds a restriction requiring that trees cut from such property shall not be less than eight inches in diameter at the butt.

SECTION 3. The state forester may in his discretion, but subject to the approval of the deed and title by the attorney-general as provided in section one, accept on behalf of the commonwealth gifts of land to be held and managed for the purpose hereinbefore expressed. A donor of such land may reserve the right to buy back the land in accordance with the provisions of section two, but in the absence of a provision to that effect in his deed of gift he shall not have such right.

SECTION 4. Land acquired under the provisions of this act shall be under the control and management of the state forester, who may, subject to the approval of the governor and council, cut and sell trees, wood and other produce therefrom.

SECTION 5. All moneys received by or payable to the commonwealth or any one acting on its behalf under the provisions of this act shall be paid into the treasury of the commonwealth.

SECTION 6. Land acquired under the provisions of this act, and subsequently reconveyed under the provisions of sections two or three, shall not be exempt from taxation on account of any plantation of trees set out or planted while it was held by the commonwealth.

SECTION 7. For the purpose of assisting in reforestation a portion, not exceeding twenty per cent of the money authorized by this act to be expended may be used by the state forester for the distribution at not less than cost of seeds and seedlings to land owners who are citizens of the commonwealth, under such conditions and restrictions as the state forester, subject to the approval of the governor and council, may deem advisable.

SECTION 8. The state forester shall replant or otherwise manage all land acquired by the commonwealth and held by it under the provisions of this act, in such manner as will, in his judgment, produce the best forest growth both as to practical forestry results and protection of water supplies.

SECTION 9. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 10. This act shall take effect upon its passage.

FORM OF APPLICATION USED IN ASKING FOR AN EXAMINATION OF WOODLAND.

Massachusetts State Forester,

State House,

Boston.

The State Forester is charged with the work of promoting the perpetuation, extension and proper management of the forest lands of the Commonwealth, both public and private (1904, Chap. 409, Sect. 2). The department is open for consultation on forest and shade tree planting, woodlot management, wood and lumber markets, prices, the control of insects and diseases affecting woodland and shade trees, taxation, and all matters pertaining to the care of woodland and ornamental trees. In matters pertaining to fruit growing, however, go to your local county agricultural agent. While good advice can be given through correspondence, office interviews and publications, often a personal examination of the property or trees, themselves, by one of my technical assistants where the advice can be extended on the ground, is the only satisfactory method of procedure. The only charge for such service is the traveling expenses of the forester making such examination. If you care to have such an examination, fill out the attached application blank and mail to our office. A brief description of the land and the problem involved will assist us.

F. W. RANE,
State Forester.

APPLICATION FOR AN EXAMINATION.

Understanding the condition named above, I desire to have an examination made of a tract of land of approximately .....acres located in the town of....., State of Massachusetts.

Signed .....

Address .....

Telephone .....

Date.....191 .

Scenery along the Mohawk Trail.

Public Document No. 73

The Commonwealth of Massachusetts

ANNUAL REPORT

OF THE

COMMISSIONER OF CONSERVATION

AND

STATE FORESTER

FOR THE

YEAR ENDING NOVEMBER 30, 1920

DEPARTMENT OF CONSERVATION

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET

Scenery along the Mohawk Trail.

Public Document No. 73

The Commonwealth of Massachusetts

ANNUAL REPORT

OF THE

COMMISSIONER OF CONSERVATION

AND

STATE FORESTER

FOR THE

YEAR ENDING NOVEMBER 30, 1920

DEPARTMENT OF CONSERVATION

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

The Commonwealth of Massachusetts

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts.

I respectfully present herewith for your consideration my annual report as Commissioner of Conservation for the fiscal year ending Nov. 30, 1920.

WILLIAM A. L. BAZELEY.

CONTENTS.

Part I.

Report of Commissioner of Conservation.

	PAGE
Forestry,	12
Fish and Game,	13
Animal Industry,	14
New Forest Law,	15
Mount Grace,	17
Standish Monument Reservation,	18
Forest Fires,	19
Conventions,	19
Financial Statements:	
Purchase and Development of State Forests,	20
Purchase of Mount Grace,	21
Maintenance of Standish Monument,	21
Recommendations:	
Division of Forestry,	21
Division of Fisheries and Game,	23

Part II.

Division of Forestry.

Organization,	32
State Plantations,	33
Examinations,	35
Nursery Work,	35
Tree Planting in 1920,	39
Forest Survey of Hampshire County,	40
White Pine Blister Rust,	40
White Pine Weevil,	41
State Forests,	42
Report of State Fire Warden,	45
Report of Superintendent of Gypsy Moth Work,	53
General Conditions,	53
Spraying Apparatus,	54
Brown-tail Moths,	54
Cranberry Bog Work,	55
Satin Moth,	55
Lynn Woods,	56
Lumber Operations,	56
State Highway Work,	57
Federal Work,	57
North Shore Work,	59

Appendix.

Financial Statement,	63
Summary of Town Expenditures,	64
Distribution of Supplies,	73
Expenditures and Receipts on State Forests,	74
List of Forest Wardens and Local Moth Superintendents,	75

OUTLINE OF REPORT.

This report is divided for convenience and economy into four parts: —

Part I. The organization and general work of the Department of Conservation.
Part II. The activities of the Division of Forestry.
Part III. The work of the Division of Fisheries and Game.
Part IV. The work of the Division of Animal Industry.

Parts I and II are printed in one volume, under Public Document No. 73.

Part III is printed in a separate volume, under Public Document No. 25.

Part IV is printed in a separate volume, under Public Document No. 98.

OUTLINE OF REPORT.

This report is divided for convenience and economy into four parts: —

Part I. The organization and general work of the Department of Conservation.
Part II. The activities of the Division of Forestry.
Part III. The work of the Division of Fisheries and Game.
Part IV. The work of the Division of Animal Industry.

Parts I and II are printed in one volume, under Public Document No. 73.

Part III is printed in a separate volume, under Public Document No. 25.

Part IV is printed in a separate volume, under Public Document No. 98.

PART I

REPORT OF THE COMMISSIONER OF CONSERVATION

The Commonwealth of Massachusetts

ANNUAL REPORT OF THE COMMISSIONER OF CONSERVATION.

The Constitutional Convention, assembled in 1918, passed an amendment, later adopted by the people, by the provisions of which the Legislature was required to reorganize the executive and administrative work of the Commonwealth into not more than twenty departments. To do that without causing serious interruption to the numerous activities carried on by the various departments, boards, and commissions was recognized as a difficult task. The nature of the problem was such as to require very careful study and painstaking labor by the committee charged with its solution, and finally resulted in the passage of an act (chapter 350, General Acts of 1919) which embodied in a satisfactory manner the constitutional mandate.

By this legislation was created the Department of Conservation, into which were merged the office of the State Forester, the State Forest Commission, the Commission on Fisheries and Game, and the Department of Animal Industry. In accordance with the provisions of this act the Department was to be organized in three divisions, — namely, a Division of Forestry, a Division of Fisheries and Game, and a Division of Animal Industry, and to be under the supervision and control of a commissioner, each division being under the charge of a director. The law further provided that the Commissioner of Conservation should be designated as director of one of the divisions.

As Commissioner of Conservation His Excellency the Governor appointed William A. L. Bazeley of Uxbridge, at the same time designating him Director of the Division of Forestry; as Director of the Division of Fisheries and Game, William C. Adams of Newton; and, as the Department of

Animal Industry was not abolished by the so-called consolidation act, but with its complete organization was placed in the Department of Conservation, Dr. Lester H. Howard of Boston has continued to direct the affairs of that division. As the act provided that the directors of divisions should act as advisers to the Commissioner, semi-monthly meetings have been held throughout the year at the office of the Commissioner, at which questions of a departmental nature have been determined by vote. In addition to the regular meetings the Commissioner found it necessary to call many special meetings to consider questions of more or less urgency.

Conservation of Our Forests.

There is no argument needed to convince those who have thought on the matter of the vital necessity for the earnest support by all people of a policy of wise conservation of our forests. Nowhere else has lumber been so potent a factor in development as in the United States. The houses in which our citizens dwell, the more than 200,000 miles of railroads, the development of our great industrial centers, our vast engineering projects, — in fact, that marvelous development in all the elements of power and prosperity which we enjoy, — have been due in no small measure to the lavish use of our forest products. The absolute necessity of maintaining this source of wealth is apparent. Conservation and perpetuation of our forests mean to so utilize them as to make them continuous, which can be done only by spending money annually in reforesting our lands and securing to them adequate safeguards from those agencies, such as fire and insects, which threaten to destroy them.

Forestry is a comparatively new science in this country, and nowhere is there greater need for the adoption of its teachings, nor are the conditions for a broad forestry policy more favorable, than in Massachusetts. It should be thoroughly understood that scientific forestry does not mean the utilization of soil suitable for agriculture, but only the retention for timber growing of lands less profitable for other purposes, which applies to more than one-half the area of Massachusetts.

It is obvious that our forest problems differ in some respects

from those of other States where virgin forests have been acquired by legislative enactment and are being scientifically managed. In Massachusetts the problem is essentially one of reclamation.

Massachusetts, once self-supporting in lumber, now has to import 70 per cent of the amount used. This condition should not be allowed to continue. Our idle lands must be put to work. The people at large must be educated in the value and benefits to be derived from a permanent forest policy.

Fish and Game.

By the grouping of the activities of forestry and fisheries and game in the Department of Conservation the work which is closely interrelated in many respects was brought into fuller co-operation.

It is an elementary principle that the protection and increase of the wild life of the State are dependent on a suitable environment; that the most important requirement is sufficient forestation to afford the wild life hiding places from enemies, protection against the elements, and food supply. The forests can exist without the wild life. The wild life can exist in only limited numbers and species without the forests.

The same propositions are true with respect to the inland fisheries. The vegetation of our forests graduates the melting snows, holding back the spring torrents which are injurious to our streams. In its shaded recesses are held the countless small reservoirs that insure sufficient water in the dry seasons. Its protection from the hot rays of the summer suns keeps the temperature of many brooks sufficiently low that fish may thrive in maximum numbers, and its dense covering along banks and shores affords great protection from predatory birds and animals.

It is the function of one division to preserve and increase this great wealth of vegetation. It is the duty of the other division to protect the wild life thus harbored, and to assist by artificial propagation. Both divisions should work hand in hand in the education of the public to use wisely and enjoy moderately this natural wealth with which the Commonwealth was once so generously endowed.

Animal Industry.

It is a well-recognized fact that the human race could not exist without the domestic animal.

Each of the different species, therefore, commands our attention and demands its conservation to the greatest extent possible, as an important public work of the State and Nation. Domestic animals are not only producers of food for human consumption, but are recognized as necessary adjuncts to successful agriculture; important factors in the doing of the world's work, as indispensable in war as in peace; a means of recreation and pleasure to the people; and invaluable as mute servants in the manufacture of biological products for the preservation of the public health.

The numbers of domestic animals propagated, produced, and raised to a point where they furnish the service demanded of them depend largely upon the prevention of contagious disease, or its control and eradication after its outbreak; and it is in this work, the conservation of animal life, that the Division of Animal Industry is actively engaged.

To refer only to their value as food producers: it is estimated that 37 per cent of the food of the people of this country has for its source the domestic animal. This is represented by dairy products, such as milk, butter and cheese, and the meat value of their carcasses as beef, pork and mutton, either fresh, cured, or variously manufactured, if such carcasses are found healthy at time of slaughter.

In a recent year, at seven of the principal packing houses in the United States, there was condemned as unfit for food, on account of lesions of one disease only (tuberculosis), what would amount to 50 train loads of 40 cars each of beef cattle.

Millions of pounds of pork products are now saved yearly in Massachusetts through the immunization, by the Division of Animal Industry, of swine against their principal disease, — hog cholera.

By this work in conservation of food-producing animals there is also made commercially possible the utilization of garbage for feeding purposes, which was formerly a great household waste. At the same time, and by the same means,

what was formerly an unsafe project has become a present-day business success of no small dimensions.

Lack of space precludes further reference to the conservation work of the Division of Animal Industry in many other directions, notably its important relation to conservation of human life by the control of such animal diseases as are communicable to, and rapidly fatal in, the human subject.

For further detail in regard to these matters we refer to the report of the Division of Animal Industry.

New Forest Law.

While from the time the State first committed itself to the practice of scientific forestry gradual yet encouraging progress has been witnessed, the passage of the forest bill at the last session of the General Court signalized the greatest advancement ever made in any one year. It may fairly be claimed that to the enthusiastic and untiring efforts of the Massachusetts Forestry Association is due in large part the enactment of this legislation, although it should be noted that it also received the very earnest support of many prominent lumber operators. The importance of this act justifies us in printing its text in full.

Chapter 604.

An Act to provide for the Purchase and Development of State Forests.

Be it enacted, etc., as follows:

Section 1. The commissioner of conservation may purchase and hold additional lands within the commonwealth suitable for the production of timber to the extent of not more than one hundred thousand acres.

Section 2. The said lands shall be purchased within a period of fifteen years at a rate not exceeding the maximum price per acre already fixed by section two of chapter seven hundred and twenty of the acts of nineteen hundred and fourteen, and acts in amendment thereof and addition thereto, for the purchase of such lands, or at such price as the general court may from time to time determine.

Section 3. The department of conservation shall proceed to reclaim the said lands, by replanting or otherwise, for the purpose of producing timber and protecting the water supply of the commonwealth.

Section 4. The commissioner of conservation may in his discretion make rules and regulations relative to hunting and fishing or other uses of any lands acquired under the provisions of this act, provided that such

rules and regulations shall be subject to any restrictions imposed by laws now or hereafter in force for the protection of fish, birds and quadrupeds. The provisions of chapter three hundred and sixty-two of the acts of nineteen hundred and nine shall not apply to lands acquired under this act.

SECTION 5. Cities and towns may acquire by purchase, gift or bequest lands for the purpose of forestation, at a rate not exceeding the maximum price per acre fixed by section two of said chapter seven hundred and twenty and acts in amendment thereof and addition thereto, and may reclaim and plant such lands; and the said department may, upon application in such form as the commissioner may prescribe, furnish such cities and towns, free of charge, with seedlings for the planting of their lands.

SECTION 6. For the purpose of meeting the expenditures authorized by this act, the said department may expend during the said period of fifteen years such sums, not exceeding three million dollars, as the general court may from time to time appropriate.

SECTION 7. This act is hereby declared to be in substance a substitute for the proposed law accompanying the initiative petition transmitted by the secretary of the commonwealth to the general court on the seventh day of January, nineteen hundred and twenty, and printed as house document number thirty-seven, and shall take effect on the day following the first Wednesday in August of the current year, provided that if the said initiative petition is completed, as required by the constitution, by filing the required number of signatures on said first Wednesday, this act shall be void. [*Approved June 4, 1920.*

Accomplishments under the Act.

Because of the fact that the act did not take effect until August 5, only $50,000 was made available for use for the remainder of the fiscal year. During the three months in which the Commissioner has had to act he has succeeded in purchasing 5,339 acres of land, in five separate tracts, as well as adding some acres to the State forests already established. The new forests may be described as follows: —

The Laurel Lake Forest is located in the easterly part of Erving, in Franklin County. It has a frontage of three-quarters of a mile on the Greenfield State road, and extends northerly 2 miles. It nearly surrounds a little pond known as Laurel Lake, hence the name.

The Conway Forest is located in the south part of Conway. It takes in the watershed of Avery Brook, which is the source of water supply for Northampton, and adjoins 1,000 acres belonging to the water department of that city.

Mount Grace as seen from Warwick Village.

The Tolland Forest is located in the south part of Tolland, on the Connecticut State line. This land was originally part of a large landed estate known as the Howell lands, the other part being in the town of Hartland, Conn. The State Forester of Connecticut is asking for an appropriation for State forests, and if he gets it may purchase the Howell lands in Connecticut, so that the reunited property will form a sort of interstate park.

The Farmington River Forest is located in the northwestern part of Tolland, on the banks of the west branch of the Farmington River and the shores of Otis Reservoir, one of the largest bodies of fresh water in the State.

Nearly ten years ago the Forestry Department acquired some 500 acres of land on Christian Hill, in the town of Colrain. This area has been entirely reforested, and contains our prize plantation of white pine. We have decided to turn this reforestation lot into a State forest by adding to it available adjoining lands, and have made arrangements to purchase 400 acres additional.

It has been the endeavor of the Department to acquire this land at a price less than $5 per acre, and we have been successful in securing it all at an average price of $4.50. We have been happily surprised at the amount of land available at this price and the high quality of most of it. Probably three-fourths of it is so well stocked with natural reproduction of good quality that it will never need to be artificially reforested, but will be improved by the application of modern forestry methods. Of course the last 10,000 acres will come harder than the first, but we are greatly encouraged at the progress so far made.

Mount Grace.

It has long been the policy of Massachusetts, emulating the example of the Federal government as seen in our national parks, to preserve for ourselves and posterity certain tracts of land conspicuous for their scenic beauty, such as Mount Greylock, Mount Wachusett, the historic and beautiful Sugar Loaf, Purgatory Chasm, and other spots renowned for their beauty or historic value. It is an undisputed fact that the

wholesome pleasure which we derive from the contemplation of these beautiful gifts of nature arouses within us sentiments that serve to create a more loyal and higher order of citizenship. The General Court at its last session indicated its belief in the wisdom of continuing this policy by the passage of an act conferring upon the Commissioner of Conservation the necessary authority to acquire by purchase, or otherwise, Mount Grace, in the town of Warwick. Land acquisitions under this act began during November. At the close of the fiscal year there had been acquired 400 acres, at an average price per acre of $50.

The purchases already made comprise most of the southern end of Mount Grace, extending from the site of the fire observation tower to the main highway, which to a large extent constitutes the reservation's exterior boundary. It has been considered desirable, where possible, to acquire the Mount Grace lands with all the tree growth intact, and the purchases so far made include some excellent stands of forest trees, both conifers and hardwoods. Future cuttings, when it becomes advisable to make them, can be made in accordance with well-known forestry principles. The Mount Grace lands, when further purchases are completed, will constitute an excellent State reservation. The survey of the tract will be made during the year 1921.

Standish Monument Reservation.

Acting under the provisions of chapter 456 of the Acts of 1920 the Standish Monument Association, on Aug. 6, 1920, conveyed to the Commonwealth the monument and grounds in the town of Duxbury, the same to be known hereafter as the Standish Monument Reservation, and to be under the control and management of the Commissioner of Conservation.

The erection of this monument was begun in 1872, and it is located on a part of the farm given to Capt. Myles Standish by the colony about 1630, and is commemorative of the genius and renown of the first military captain of the colonies.

During the past few years the Standish Association has not been in a position to make necessary repairs on the property; therefore when it was taken over by the Commonwealth it

Myles Standish monument, on Captain's Hill, Duxbury. Located on the homestead of the militant Pilgrim, it commemorates his invaluable service to the Plymouth Colony.

presented a very unkempt appearance. Because of the great number of people who will undoubtedly visit the monument and stand upon its historic grounds during the tercentenary celebration, already opened, the Commissioner took prompt measures to cause the necessary repairs to be made on the monument and the approaches thereto.

Forest Fires.

As the first and most obvious necessity to the successful consummation of a forest policy is an adequate forest fire protective system, our faculties and energies have been directed to the establishment of such a system, and while the operation of this system has served to reduce to a marked degree the annual losses caused by forest fires, it may yet be strengthened and perfected. One of the most important features of a program designed to deal with this evil is the education of the people. It is generally admitted that 95 per cent of our forest fire waste arises primarily from the carelessness and more or less indifferent attitude of the general public. The writer believes that when we have succeeded in arousing and educating public opinion on this subject we shall have accomplished much in the direction of reducing our forest fire losses to reasonable proportions, and securing a much more confident attitude toward general forestry.

We cannot dismiss the subject of fire control without expressing our appreciation of the commendable spirit manifested by the sportsmen throughout the State with respect to the suspension of the hunting season last fall by the Governor, on recommendation of the Commissioner of Conservation, which action was deemed expedient because of the extreme drought and consequent fire hazard.

The report of the State Fire Warden, found in the report of the State Forester, records in detail the work accomplished along these lines during the past year.

Conventions.

The Commissioner has attended several conventions held outside the State during the past year where questions of moment relating to the work of conservation were discussed.

These meetings were held under the auspices of the following organizations: —

The American Plant Pest Control Committee, to consider the white pine blister rust problem, held at Albany, N. Y., in December.
The Annual Meeting of the Society of American Foresters, held at New York, N. Y., in December.
State Foresters and United States Forest Service, on the subject of forest fire prevention, held at Albany, N. Y., in February.
The Annual Meeting of the American Game Protective Association, held at New York, N. Y., in March.
New England Section of the Society of American Foresters, held at Keene, N. H., in August.
Association of Northeastern Foresters, held at Grand Mere, Can., in August.
Meeting of State Foresters, held at Atlantic City, N. J., in November.

In addition to the above the Commissioner has attended several meetings of a similar nature held in Boston and elsewhere in the State, worthy of special notice being those held under the auspices of the Eastern Shook and Wooden Box Manufacturers Association, as they indicate the lively interest being taken by the lumber operators and manufacturers in the conservation movement.

Financial Statement.

Purchase and Development of State Forests.

[Chapter 604, Acts of 1920.]

Receipts.

Appropriation (Aug. 5, 1920),	$50,000 00

Expenditures.

Salaries,	$942 75	
Travel,	332 30	
Maps, photographs, etc.,	62 85	
Equipment,	1,675 60	
Express, teaming, etc.,	24 88	
Sundries,	10 95	
Land,	24,475 00	
		27,524 33
Balance on hand Nov. 30, 1920,		$22,475 67

PURCHASE OF MOUNT GRACE.

[Chapter 606, Acts of 1920.]

Receipts.

Appropriation (June 5, 1920),	$50,000 00

Expenditures.

Land,	20,250 00
Balance on hand Nov. 30, 1920,	$29,750 00

MAINTENANCE OF STANDISH MONUMENT.

[Chapter 456, Acts of 1920.]

Receipts.

Appropriation for 1920,	$3,000 00

Expenditures.

Salaries,	$1,868 20	
Travel,	49 76	
Supplies,	849 07	
Equipment,	174 80	
Express, teaming, etc.,	46 08	
Sundries,	4 49	
		2,992 40
Balance returned to treasury Nov. 30, 1920,		$7 60

RECOMMENDATIONS FOR LEGISLATION.

The following are the recommendations of the Commissioner for legislative action, all of which have been forwarded to the Secretary of the Commonwealth, together with drafts of the statutes which should be enacted to accomplish the end desired, in accordance with the provisions of chapter 131, General Acts of 1919.

Division of Forestry.

I. *Establishment of the Mohawk Trail Reservation.* — Probably nowhere east of the Rocky Mountains is there a highway passing through scenery of more sublime grandeur than the so-called Mohawk Trail. Since the completion of this highway hundreds of thousands of people from all parts of the

United States have annually traveled over this route and gazed with delight upon the beautiful wooded mountains, rivers, passes and ridges which make the noble landscapes that lie around them. The impression which the wildness and majesty of the scenery make upon the senses is singularly grand and uplifting to those privileged to feast upon its loveliness. The Commonwealth can ill afford to jeopardize so valuable an asset. The devastating axe of the lumberman already threatens to destroy the forest growth on these slopes, and that their beauty shall not be marred the Commissioner believes that the Commonwealth should at once acquire, by purchase or otherwise, such lands as may be necessary to preserve the charm and beauty of this highway. The Commissioner therefore recommends the passage of an act to accomplish this purpose.

II. *Appointment of Forest Wardens.* — The statutes provide for the appointment in the month of January, by the mayor and aldermen in cities and the selectmen in towns, of a forest warden. It frequently happens, especially in the smaller towns, that through an oversight or some other cause such appointment is not made. This always renders it difficult to properly organize the fire prevention system before the dangerous season opens. For that reason the Commissioner recommends the enactment of a law authorizing him to fill such vacancy.

III. *Forest Fire Warden Conventions.* — Recognizing the great value derived from an annual convention of the forest fire wardens for the purpose of discussing methods of fire fighting and improved equipment, the Commissioner believes that the law should be so amended as to make attendance upon such conventions one of the duties of forest wardens.

IV. *Reimbursement of Towns for Loss of Taxes.* — The Commissioner holds the opinion that a statute should be enacted by which the State forests shall be more equitably taxed. Under the present law the Tax Commissioner is required to make a valuation once every five years. Therefore it could frequently happen that after the removal of forest products the valuation would remain unchanged until a new valuation was made, which might be several years. The

Commissioner believes that the law should be so amended as to provide for the reduction of the valuation to correspond with the value of the forest products removed from such land, and recommends the passage of an act to accomplish this purpose.

V. *Exemption from Civil Service.* — Because of the fact that in the purchase and development of State forests many persons are employed temporarily when immediate service is required, the Commissioner recommends that such employees be not subject to the rules and regulations required by civil service.

VI. *Replacement of Forest Fire Equipment.* — For the purpose of strengthening the forest fire protective system, and to encourage towns to become properly equipped with fire-fighting apparatus, a law was enacted in 1910 providing for the partial reimbursement of certain towns for the cost of such equipment. This law has now been in force ten years, and nearly all the towns entitled to come within the provisions of the act have availed themselves of the opportunity. In many of these towns long use has caused deterioration of the equipment to a point where replacement has become a necessity. The Commissioner is of the opinion that the State may very wisely continue its policy of aiding these towns by reimbursing them a certain amount of the cost of renewing such apparatus as may now be unserviceable.

VII. *Extending the Time of the Hunting Season.* — The Commissioner considers that justice to the sportsmen of the Commonwealth requires that the law empowering the Governor to suspend the hunting season during periods of extreme drought so as to prevent forest fires should be so amended as to provide that the said season be extended for a number of days equal to the number it was found necessary to suspend it. The Commissioner therefore recommends the passage of an act to accomplish this purpose.

Division of Fisheries and Game.

I. *To amend the Law relative to issuing Hunting and Fishing Licenses.* — The present law requires licenses for fishing in only those inland waters which have been stocked by this

Department since Jan. 1, 1910. The publication yearly of lists of waters stocked during the year involves considerable expense. Further, by reason of the fact that many streams are known by various names, much confusion is created in the minds of persons who wish to determine whether a stream has or has not been stocked. Many of the unstocked inland waters are being depleted, and we believe they should be protected by requiring licenses for fishing therein.

A person wishing to secure a duplicate of a lost or destroyed license is required by the present law to apply, either in person or by letter, at the office of the Division of Fisheries and Game. This is an inconvenience to the public, and creates a volume of work in the office of the division at the busiest season of the year. An amendment permitting the issuance of duplicates by city and town clerks will remedy this, and the 25-cent fee will have the effect of reducing the number of licenses lost.

Under the existing law there is no limit to the amount of fish or game which a non-resident may take out of the State under his license, except in the case of birds and brook trout. Inasmuch as the Department is bending every effort to conserve the supply of wild life within the Commonwealth, it seems only just and fair that a limit be set.

II. *To provide a Penalty for destroying or injuring Private Property while Hunting, Trapping or Fishing.* — Instances have occurred where thoughtless hunters and fishermen have destroyed or injured private property while pursuing their sport. In order to safeguard the rights of landowners; to secure for the Fish and Game Division their hearty co-operation in the conservation of wild life rather than their condemnation of all things relating to hunting and fishing; and to spare the true sportsman the injustice of being obliged to share the blame for the deeds of the unmindful, we believe that the accompanying bill is timely and necessary.

III. *To empower Fish and Game Wardens to arrest Persons who assault them or interfere with them in the Performance of their Duties.* — At the present time the fish and game wardens have no authority to forthwith arrest persons who would assault them or interfere with them in the performance of

Roadside denuded of forest growth along the Mohawk Trail.

their duties. Much of their work being done at night, when recognition of such persons is impossible, without the power of arrest on the spot there is no redress for the wardens. A case in point occurred a short time ago when two wardens were attacked and forced to take to cover to protect themselves from injury, since they had no right to charge the crowd and arrest the offenders.

IV. *To provide for Payment for Damage caused by Moose.* — Many times the moose which are at large in the Commonwealth have caused damage to private property. We deem it fair and just that compensation for such damage should be paid as in the case of damage done by deer.

V. *To regulate the Release within the Commonwealth of Wild Birds or Animals.* — Cases have come to our attention of the liberation, by breeders, of game birds or animals, or sick or diseased stock. To safeguard the health of the stock in the wild, we deem it necessary to reserve the right to judge what fish or animals may be liberated. The liberation of fish in waters of the Commonwealth is already, by law, placed under the control of the Department.

VI. *To correct the Law relating to Fur-bearing Animals.* — Because of the omission of the month of March from the open season on muskrats, and because the section relating to the training of dogs is not plain to the layman, amendment of the law is necessary as set forth in the accompanying act.

VII. *To permit the Importation into Massachusetts of Fish and Game taken legally outside the Commonwealth, and to permit Possession of Such Fish and Game after the Close of the Season.* — The present laws permit the taking of a bag limit of fish and game on the last day of the open seasons; but the person taking it cannot reasonably be expected to dispose of the same immediately. The accompanying act will give a reasonable length of time for the disposal of game and fish legally taken during the open season. It will also permit the importation and possession, after the close of seasons in Massachusetts, of fish and game taken legally outside of the Commonwealth.

VIII. *To permit the Importation of European or Gray Partridge.* — In order to encourage the local breeding of

European or gray partridge, this species was not mentioned in section 5 of chapter 567, Acts of 1912, among the species which might be imported from without the United States. But as no disposition has been shown by local breeders to propagate them, it appears advisable to meet the demand for these birds by authorizing their importation. For this reason we recommend that this species be included in the birds named in section 5 of said act.

IX. *To permit the Killing or Trapping of Predatory Birds or Animals within Reservations.* — The authority for the issuance of permits to destroy harmful birds or animals on reservations is limited, by section 4, chapter 410, Acts of 1911, to issuance to wardens or owners or occupants of land within the reservations. For the better protection of useful wild life it is desirable that the Department's authority be extended to the issuance of permits to any responsible person who may be willing to assist in the destruction of undesirable species.

X. *To amend the Law pertaining to Wild or Undomesticated Birds.* — Section 7, chapter 92, of the Revised Laws was enacted before ducks, geese and waterfowl were protected by law. It is now necessary to omit these species from the law in order to avoid conflict with subsequent laws.

XI. *To make the Laws of Massachusetts relative to Migratory Birds conform with the Laws of the United States.* — The Federal government has entered into a treaty with Great Britain for the uniform protection of migratory birds on the American continent. The Federal laws in this connection render conflicting State laws void. For the convenience of the public, and for the proper enforcement of the law, it is desirable to have the laws of this Commonwealth conform with the Federal rules and regulations.

XII. *To regulate the Catching and Sale of Fresh-water Fish.* — Winter fishing and absence of restriction on the sale of pond fish have been two of the principal causes of the depletion of inland fisheries during the past few years. Progressive conservation demands that catch and sale limits be established.

XIII. *To permit the Taking of Eels in the Vicinity of Hingham Harbor.* — Inasmuch as eels have done much damage to the smelt fisheries in this vicinity, which are the principal

remaining smelt fisheries of the State, the taking of eels in this locality should be permitted, notwithstanding the provisions of chapter 27, General Acts of 1916.

XIV. *To regulate the Taking of Lobsters.* — The laws of Rhode Island, Connecticut and New York provide for the measurement of lobsters according to the so-called body measure. The State of Maine this year proposes to amend its law so as to adopt the same method, with a view to furthering the movement for a uniform measure for New England and New York. Uniform method of measurement will increase the chance for co-operation among the adjacent States. The size of legal lobsters will remain practically the same, and the chance for confusion will be eliminated.

XV. *Relative to taking Fresh-water Fish.* — The increased number of fishermen, the accessibility of waters by reason of the automobile, the great expense of artificial propagation on a scale sufficient to meet the requirements, make it imperative that the taking of fresh-water fish from our inland waters should be limited to a reasonable number per day.

PART II

REPORT OF THE DIVISION OF FORESTRY

PART II

REPORT OF THE DIVISION OF FORESTRY

REPORT OF THE DIVISION OF FORESTRY.

Naturally the first matter to which the State Forester directed his attention upon assuming control of the Division of Forestry was to acquaint himself with the personnel of its organization and their work. A careful study of the duties and responsibility of each disclosed the existence of more or less overlapping of functions and a certain amount of indefiniteness with respect to authority, which was a condition not conducive to securing the fullest measure of efficiency. A reorganization was effected whereby the duties and authority of each member of the organization were so clearly outlined as to remove all uncertainty with respect to responsibility. The wisdom of this action is reflected in the increased confidence and interest in their work of the entire personnel.

In pursuance of this policy Mr. Harold O. Cook was recalled to the Department and made chief forester, which position calls for a technical forestry education and training. Mr. James Morris was given charge of all the forest nurseries. Mr. Frank L. Haynes was placed in charge of the then existing State forests, as he had been formerly the forest examiner for the State Forest Commission. Mr. R. B. Parmenter, one of the field foremen, but a forester by profession, was made assistant forester, and has been doing examination and other technical work for Mr. Cook. Mr. Francis V. Learoyd, who had served as purchasing agent and district forest warden, was made business agent and put in charge of all the purchasing of the Department.

Late in the fall, as the work of purchasing land under chapter 604, Acts of 1920, was taken up, the work of examination and other necessary matters connected with the acquisition of the new State forests were placed in the hands of Mr. Frank L. Haynes, and the care of the five State forests already

acquired was turned over to Mr. Maxwell C. Hutchins, the State Fire Warden. The work of gypsy-moth thinnings as carried on by the moth department for several years was discontinued, and Mr. Paul D. Kneeland left the service of the State Forester to accept a position with the Baker Box Company. All gypsy-moth work was placed directly in the hands of Mr. George A. Smith, the superintendent, and he was given full authority over all employees in this branch of the work. Mr. John H. Montle, observer at Fall River, was promoted to the position of district forest warden, left vacant by the promotion of Mr. Learoyd.

The present organization is as follows: —

Organization.

William A. L. Bazeley, . . . Commissioner and State Forester.

Forestry Division.

General Staff.

Charles O. Bailey,	Secretary.
Elizabeth Hubbard,	Senior clerk.
Elizabeth T. Harraghy,	Stenographer.
Jennie D. Kenyon,	Stenographer.
Mabel R. Hamnett,	Clerk.
Dorothy J. Sanford,	Assistant clerk.

General Forestry.

Harold O. Cook,	Chief forester.
Frank L. Haynes,	Assistant forester.
James Morris,	Assistant forester.
Robert B. Parmenter,	Assistant forester.
John A. Palmer,	Superintendent, Amherst Nursery.
Fred W. Parker,	Superintendent, Bridgewater Nursery.
Eben Smith,	Superintendent, Barnstable Nursery.

Moth Work.

George A. Smith,	Superintendent.
Francis V. Learoyd,	Business agent.

District Moth Men.

1. Michael H. Donovan, Beverly.
2. William A. Hatch, Marlborough.
3. John J. Fitzgerald, Haverhill.
4. Clarence W. Parkhurst, Foxborough.
5. Walter F. Holmes, Bussard's Bay.
6. Harry B. Ramsey, Worcester.

FOREST FIRE PREVENTION.

MAXWELL C. HUTCHINS, . . . State Fire Warden.
JOSEPHA L. GALLAGHER, . . . Clerk.

District Fire Wardens.

1. JAMES E. MOLOY, Woburn.
2. JOHN H. MONTLE, Fall River.
3. JOSEPH J. SHEPHERD, Pembroke.
4. JOHN P. CROWE, Westborough.
5. ALBERT R. ORDWAY, Westfield.

Observers and Location of Fire Towers.

Mrs. JOHN CONDON, Harwich.
JOSEPH W. JENKINS, Barnstable.
Mrs. W. I. MOODY, Falmouth.
W. F. RAYMOND, Bourne.
F. L. BUCKINGHAM, Kingston.
Mrs. ALLAN KENISTON, Martha's Vineyard.
S. EDWARD MATTHEWS, Middleborough.
GEORGE T. MOFFETT, Fall River.
R. J. ZILCH, Rehoboth.
CHAS. F. KIMBALL, Hanson.
EDWARD D. SPRAGUE, Hingham.
F. J. KUSTENMACHER, Sharon.
FRED R. STONE, Sudbury.
WM. H. TYZZER, Jr., Wakefield.
C. E. BLOOD, Chelmsford.
LEON S. GIFFORD, Georgetown.
CAPLIS McCORMACK, Manchester.
ROBERT McLAUGHLIN, Mendon.
WILLIAM E. HOWARTH, Westborough.
JAMES W. MALEY, Wachusett Mountain.
MARK W. SHATTUCK, Watatic Mountain.
WM. E. TAYLOR, Warwick.
HARLAND BURROWS, Pelham.
MARY E. HALEY, Brimfield.
THOMAS MAGOVERN, Charlton.
TIMOTHY SHEA, Mount Tom.
N. C. WOODWARD, Shelburne Falls.
H. H. FITZROY, Savoy.
DAVID M. SMITH, Waltham.
FRANK WILSON, Chester.
JOHN E. CURTIN, Tolland.
FREDERICK K. SHEARS, Mount Everett.
ROBERT MILLER, Lenox.
HARRY GEORGE, Williamstown.
ALTON B. ELLIS, Acushnet.
ALVA SIKES, West Brookfield.
EUGENE SULLIVAN, Agawam.

STATE PLANTATIONS.

Because of the high cost and scarcity of labor in rural districts work on the plantations has been considerably curtailed. Inasmuch as a considerable proportion of these plantations are subject to redemption on the part of the original owner the Department is very loath to place any expense on them except where conditions call for immediate attention.

Five new lots were taken over this year. Planting was done on eight lots, and brush cutting on fourteen. We have changed our methods of releasing planted pine from suppression by hardwood sprouts by trimming around individual trees rather than by clear cutting of the sprout growth. We find this method less expensive, and in some ways it gives better results.

The following is a tabulated list of the work done: —

Reforestation Work.

Planting.

[W. p. = white pine; s. = spruce; r. p. = red pine.]

Lot.	Town.	Area (Acres).	Trees.
Baker-Hurd,	Rutland-Barre,	132	35,000 w. p. 3,000 s. 1,000 r. p.
Barrett,	Royalston,	10	10,000 w. p.
Briggs,	Oakham,	1½	2,000 w. p.
Hanson,	Marlborough,	95	1,000 w. p.
Judd,	South Hadley,	25	7,000 w. p.
Hodgman,	Montague,	26	4,000 w. p. 4,000 r. p.
Rockwood,	Ashburnham,	–	32,500 w. p. 7,500 r. p.
Spencer Wire Company,	Spencer,	–	7,000 w. p.
Total,		–	114,000

Brushing.

Lot.	Town.	Area (Acres).	Brushed.
Barr,	Spencer,	43	43
Briggs,	Oakham,	1½	1½
Cadwell,	Pelham,	6	6
Cadwell,	Pelham,	16	14
Chestnut Hill,	Spencer,	200	25
Clark,	Paxton,	45	45
Fenno,	Westminster,	80	20
Fullam,	North Brookfield,	5	4
Lawrence,	Fitchburg,	27	15
Lowe,	Colrain,	80	5
Robertson & Larkin,	Oakham,	80	40
Rockwood,	Ashburnham,	80	15
Spencer Wire Company,	Spencer,	8	2
Stone,	East Brookfield,	37	10
Total,		–	345

Examinations.

Private owners to the number of sixty-nine applied for examination of their woodlands and advice on the treatment thereof. This is a considerable advance over the number that applied last year. We should feel encouraged if it were not that such a large percentage of these applications were simply for help in the lumbering of their property and an estimate of the stand. However, we often find an opportunity of giving some good forestry advice even under such conditions.

Examinations.

Subject.	Number.	Acres.
Operating and estimating,	17	1,226
Planting,	14	1,314
Thinning,	10	811
Chestnut thinnings,	8	425
Insects and diseases,	9	118
General,	3	76
Thinning and planting,	8	2,045
Totals,	69	6,015

Nursery Work.

Under this heading we include the operations of our three principal nurseries at Amherst, Bridgewater and Barnstable. The nurseries located on the State forests are considered to be a part of these reservations, and their operation is made a part of the report on the individual State forests. The product of our nurseries is divided for convenience into three classes, according to its destination: first, the stock used by the Department, largely in the reforesting of State forests and State plantations; second, stock supplied free of cost to other State departments; and third, stock sold to private owners. For the first purpose, 820,000 trees were used; for the second, 250,000; and for the third, 343,000. The total is somewhat less than that of last year, because the stock available in our nurseries was less. We are glad to report, however, that the stock

available for distribution next year is larger in amount than in any previous year, and is in excess of two and one-half million four-year-old transplants. This is indeed fortunate, for with our new State forest program we shall have need of every transplant that we can raise.

STOCK SHIPPED TO FORESTRY DEPARTMENT.

SPECIES.	CLASS.	NUMBER.
White pine,	4-year transplants,	388,000
White pine,	3-year transplants,	50,000
White pine,	2-year seedlings,	60,000
Red pine,	4-year transplants,	100,500
Jack pine,	4-year transplants,	15,000
Scotch pine,	4-year transplants,	2,500
Spruce,	4-year transplants,	144,000
Spruce,	2-year seedlings,	60,000
Total,		820,000

STOCK SOLD TO PRIVATE OWNERS.

SPECIES.	CLASS.	NUMBER.
White pine,	4-year transplants,	218,430
White pine,	3-year transplants,	3,000
Scotch pine,	4-year transplants,	21,865
Scotch pine,	3-year transplants,	7,100
Norway spruce,	5-year transplants,	9,750
Norway spruce,	4-year transplants,	23,700
Norway spruce,	3-year transplants,	20,025
Arbor vitæ,	4-year transplants,	2,700
Austrian pine,	4-year transplants,	11,125
Red pine,	4-year transplants,	23,315
Jack pine,	3-year transplants,	2,890
Total,		343,900

Stock shipped to Other State Departments.

Species.	Class.	Number.
White pine,	4-year transplants,	161,500
Red pine,	4-year transplants,	45,600
Austrian pine,	4-year transplants,	11,000
Scotch pine,	4-year transplants,	11,500
Jack pine,	4-year transplants,	11,000
Arbor vitæ,	4-year transplants,	2,700
Norway spruce,	4-year transplants,	8,550
Total,		251,850

Inventory of Nursery Stock, Spring of 1921.

Amherst Nursery.

Species.	4-Year Transplants.	3-Year Transplants.	Seedlings.	Seedlings.
White pine,	554,000	140,000	275,000	360,000
Scotch pine,	240,000	250,000	–	542,000
Red pine,	32,000	–	–	–
Jack pine,	16,000	–	152,000	–
Norway spruce,	15,000	200,000	–	2,170,000
European larch,	–	1,500	–	–
Hemlock,	–	1,000	–	–
Douglas fir,	–	–	60,000	–
Arbor vitæ,	–	–	6,000	–
Austrian pine,	–	–	–	160,000
Siberian larch,	–	–	–	100,000
Totals,	857,000	592,500	493,000	3,332,000

Barnstable Nursery.

White pine,	375,000	298,000	30,000	85,000
Scotch pine,	9,000	15,000	16,000	203,000
Red pine,	45,000	–	–	–
Norway spruce,	8,000	30,500	129,000	80,000
Jack pine or banks,	–	–	25,000	–
Austrian pine,	–	–	–	70,000
Larch,	9,000	–	–	8,000
Totals,	446,000	343,500	200,000	446,000

Bridgewater Nursery.

Species.	4-Year Transplants.	3-Year Transplants.	Seedlings.	Seedlings.
White pine,	413,000	351,000	-	-
Scotch pine,	50,000	-	-	-
Jack pine or banks,	112,600	-	-	-
Red pine,	49,000	-	-	-
Norway spruce,	24,600	180,000	-	-
Totals,	649,200	531,300	-	-

Norfolk Nursery.

White pine,	20,000	-	-	-

Total Four-year Stock in Nurseries.

Amherst,	857,000
Barnstable,	446,000
Bridgewater,	649,300
Norfolk,	20,000
Total,	1,972,300

State Forest Nurseries.

Otter River Nursery.

Species.	4-Year Transplants.	3-Year Transplants.	Seedlings.	Seedlings.
White pine,	110,000	-	-	-
Scotch pine,	80,000	-	-	-
Total,	190,000	-	-	-

Savoy Mountain Nursery.

White pine,	30,000	-	-	-
Spruce,	-	60,000	-	-
Totals,	30,000	60,000	-	-

Arthur Warton Swann Nursery.

White pine,	8,000	12,500	-	-

State Forest Nurseries — Con.

MYLES STANDISH NURSERY.

SPECIES.	4-Year Transplants.	3-Year Transplants.	Seedlings.	Seedlings.
White pine,	325,000	-	50,000	-

TOTAL FOUR-YEAR STOCK IN STATE FOREST NURSERIES.

Otter River,	190,000
Savoy Mountain,	30,000
Arthur Warton Swann,	8,000
Myles Standish,	325,000
Total,	553,000

TREE PLANTING IN 1920.

A total of 343,000 evergreen trees of a variety of species was shipped from our nurseries and planted during the spring of 1920. The stock was sold to the public at an average price of $10 per thousand. These trees were distributed throughout the State and planted in the following 52 towns and cities: —

Amherst,	2,000	Millbury,	2,000
Barnstable,	2,000	Millville,	5,000
Barre,	2,000	Milton,	3,000
Becket,	2,000	Natick,	1,000
Bellingham,	1,000	Newton,	1,250
Boxford,	1,000	North Brookfield,	6,000
Brockton,	2,000	Northampton,	13,000
Brookline,	2,000	Oxford,	500
Carver,	2,000	Palmer,	4,000
Chatham,	10,600	Plymouth,	6,000
Chelsea,	2,000	Quincy,	2,000
Chester,	7,000	Rutland,	1,000
Colrain,	7,500	Sharon,	750
Concord,	3,700	Southbridge,	1,000
Falmouth,	2,000	Springfield,	3,200
Fitchburg,	95,000	Topsfield,	4,000
Framingham,	20,000	Tyngsborough,	20,000
Great Barrington,	1,000	Wakefield,	6,000
Greenfield,	1,000	Waltham,	10,000
Harvard,	9,200	Wareham,	5,000
Hingham,	3,000	Watertown,	300
Holyoke,	10,000	Wayland,	20,000
Hudson,	13,000	Westford,	500
Leominster,	6,000	Westminster,	2,000
Marblehead,	300	Winchester,	14,100
Mattapoisett,	1,000	Worcester,	4,000

Forest Survey of Hampshire County.

In continuation of our policy to obtain a complete estimate survey of the woodland conditions of the Commonwealth we began work this year in Hampshire County. The following eight towns were surveyed: Easthampton, Northampton, Southampton, Williamsburg, Cummington, Plainfield, Worthington and Middlefield. The field work was done during the vacation period, which enabled us to secure the services of students from some of the leading forest schools at small expense.

The completion of the work in this county is contemplated next summer, and the data obtained will probably be published in the form of a bulletin soon after that time. Worcester County and Plymouth County have already been surveyed, and bulletins covering the work done in these two counties may be obtained upon application. It is hoped that this important work will be continued without interruption until we have a complete inventory of the forest resources of the Commonwealth.

White Pine Blister Rust.

We have continued, as in former years, to co-operate with the Department of Agriculture in its endeavor to check the spread of the white pine blister rust, to which much publicity has been given during the past few years. As this important work is by statute placed under the jurisdiction of the Department of Agriculture, the nature of the operations carried on and progress made in controlling it may be found set forth in detail in the annual report of that department, which is accessible for reference. Attention is called, however, to the work conducted on the Otter River State Forest in an effort to remove wild currant and gooseberry plants. Of the 2,000 acres in this forest 1,300 were carefully scouted, and 393,000 plants were removed. The total cost of this operation was approximately $2,000. The cost was divided among this Department, the Department of Agriculture, and the Federal Bureau of Plant Industry. The labor was performed largely by permanent employees on the reservation, and we are pleased to state that

the character of their work was very highly commended by the Federal inspectors. The necessary work on the remaining 700 acres is contemplated next season.

That the danger from this disease is not as serious as at one time feared is indicated by the resolution adopted by the American Plant Pest Control Committee at its meeting held in Boston, Nov. 5 and 6, 1920, which declared, in substance, that the planting of white pine may be continued with comparative safety, provided that all ribes within infected areas, and at least 200 yards from pine stands, is removed.

White Pine Weevil.

An arrangement has been made between the State Forester and the Harvard Forest at Petersham, Mass., for a co-operative study of the white pine weevil in relation to forest management. In spite of the wide prevalence of this insect, especially on plantations, there is little exact information, either as to the ultimate damage it produces in a timber crop, its distribution as affected by the composition of the forest and other natural factors, or any silvicultural measures by which its depredations may be controlled or minimized. It is possible that the damage to the final yield in timber has been overestimated. Possibly, too, the spread of the beetle can be checked by regulation of the species represented in the stand. To investigate these questions Mr. H. B. Peirson, a forest entomologist, now working on the Harvard Forest, has been appointed by the State Forester a collaborator of the Division of Forestry. He will carry on a considerable part of the work at Petersham, but the State Forester has provided means for him to visit also a large number of localities throughout the State, so that the infestations of the weevil can be studied under all conditions. In view of the large program of reforestation which the State is undertaking it is highly important to find out in advance to what extent planting plans and methods of treating existing young woods can, or should, be modified to meet so apparently destructive a pest.

Other work during the year has consisted of road and boundary clearing and care of the nursery.

For fire-protective purposes a rough bridge is being built over Otter River to replace the one washed out during the spring, and the reservation house is to be connected by telephone.

Harold Parker State Forest.

Small lots, totaling 67 acres, were added to this forest during 1920. Planting of three-year-old seedlings and four-year-old transplants of white and red pine was carried on between April 15 and June 12. There were 109,000 plants set, and twenty-two men were employed during the season. The cost per thousand for planting was $12.81.

Other work done during the year consisted of opening old roads, boundary brushing and surveying, and a small amount of thinning. Data have been secured for making a type plan of the west parcel of this reservation.

The small camp on the reservation was improved and made more serviceable for use.

Savoy Mountain State Forest.

Two hundred acres were added to the Savoy Mountain State Forest this year. Owing to the ground conditions prevailing in the Berkshire region the planting work on this reservation did not begin until May 5 and continued until June 26. There were 139,000 four-year-old transplants, mostly spruce, set during the spring season, and an additional 54,000 plants of white pine were set out during October. There were 98,000 two-year spruce seedlings transplanted in a new nursery during June, and they will be available for field planting in two years. Road, boundary and survey work have constituted the other work done on this reserve during the year. Planting costs per thousand were $8.62.

Arthur Warton Swann State Forest.

During the planting season 30,000 four-year white pine transplants were set out on this reservation. Brush burning and the hauling of lumber cut during the winter constitute other work done on this reserve during the year.

Fire lines ploughed by tractor at Myles Standish State Forest.

Fire lines brushed but not ploughed.

to come, the principal activities in connection with the developing of these forests will be in the nature of fire protection. This means the construction of fire lines in some instances, notably at the Myles Standish Forest, around the entire reservation, as well as such lines as may be necessary to properly safeguard the camp sites on the lakes and the protection of the plantations. Fire protection on these forests also includes the instalment and care of suitable equipment used in fighting fires. Additional incentive for making the change, as viewed from an economic standpoint, was the fact that, except during the dangerous fire season, many of the permanent employees of this branch of the service may be used on the development work there without extra expense to the Commonwealth.

As the Boy Scout movement is now attracting much attention, it may not be considered untimely to suggest that future work on these forests offers an unusual opportunity for their activities, where their work would be of undoubted benefit to the State, at the same time affording them the enjoyment of outdoor life.

The slash law which was amended during the last session of the Legislature, requiring the clearing of a strip 40 feet around all cuttings, and along railroads and highways, as well as the clearing of all power and telephone lines, was placed in operation July 14, and is working out very satisfactorily. The additional protection assured in the clearing of power and telephone lines, thereby creating additional fire protection over the entire State, will be of immense value in the control of forest fires. The authority given to the employees of this Department in the enforcement of this law will certainly be a great help to town forest wardens in carrying out the provisions of this act. A decided improvement has already been shown in many localities.

The usual amount of construction work has been done throughout the season. A new tower 48 feet high was erected at the summit of Provens Mountain on lands of the Springfield water works in the town of Agawam. While this station is within a few miles of the Connecticut line, it was the only location that would cover certain dangerous fire areas in the county of Hampden. The 50-foot tower located at Hanson was removed to Pelham and replaced the old 30-foot wooden tower that had been in use there several years. This gives the Pelham station an additional 20 feet in height, thus greatly increasing the effectiveness of the station. A new 78-foot tower with stairs

was erected at Hanson, replacing the small tower, which had outlived its usefulness, owing to the timber growth in this vicinity obstructing the view and necessitating an addition to the height of the tower of 28 feet. This gives us an ideal station which covers an increased amount of forested area.

It seems advisable that an observation station be located at the summit of Oak Hill in the town of Harvard. The territory in this vicinity for a radius of 8 or 10 miles has been covered to some extent by distant observation towers, although we have not been able to give it adequate protection because of the fact that the distance renders it difficult for these stations to detect fires when in an incipient stage. I feel quite confident that several towns receiving benefit from this station will co-operate with us and raise sufficient funds to meet the initial cost of the tower, and possibly of its erection.

There is also some agitation relative to the necessity of a station at the summit of Mount Toby, in the town of Sunderland. This mountain and considerable area around it is owned by the State and used by the Amherst Agricultural College for demonstration purposes. The Division of Fisheries and Game also have holdings in the town of Montague that would receive protection. These State properties, together with the vast amount of forested area in that locality, would seem to warrant the establishment of a station at this point. The funds for the purchase of a tower would be furnished by Amherst College and the surrounding towns benefiting by the tower.

We are pleased to note the increased interest throughout the entire State in the purchase of forest fire fighting equipment. A large number of extinguishers, pumps and other forest fire fighting equipment has been purchased by many of the smaller towns, and a great many towns have provided themselves with motor apparatus for getting men and equipment to fires quickly. We have now about 100 towns with motor-drawn apparatus.

Forest fire conferences were held during the month of March in Middleborough, Boston and Worcester. These meetings were fairly well attended by forest wardens, deputy forest wardens and selectmen, and much interest was shown in the following discussions: the importance of fire prevention; the effect of forest fires on game life; railroad fire prevention; benefits derived from Boy Scouts; and fire fighting equipment and methods of using. On account of the heavy snow fall and conditions of the roads, it seemed advisable not to continue the

conferences throughout the western part of the State. I feel that these conferences are very important, and arrangements should be made to hold a greater number of them this coming season, so as to give an opportunity for attendance to every warden in the State. I cannot urge too strongly upon wardens their duty to attend these meetings.

In connection with our efforts to educate the public with respect to the danger of fires and the loss relative to them, we have distributed 6,000 cloth signs which have been posted in conspicuous places along roadsides, rivers and trails, and in public places such as post offices, railroad stations, etc. We have also erected on or near lands where very serious fires have occurred wooden signs, size 6 by 8 feet. The wording on these signs is significant. (See illustration.)

CARELESSNESS
CAUSED THIS FIRE

BE CAREFUL
WITH MATCHES, CIGARETTES,
CIGARS AND PIPES

WM. A. L. BAZELEY,
Commissioner of Conservation.

These signs have attracted much attention and favorable comment. Based upon investigation, I am prompted to recommend for future use metal rather than cloth signs, such as are in use in several other States, which because of their superior qualities are deemed much more economical.

An analysis of the railroad fire problem reveals that while at a first glance the number of fires occurring from this source is greater than it should be, yet, considering the fact that from 1,400 to 1,500 locomotives are traversing the railroad lines of the State daily, the number of fires caused by them is not in excess of what can be reasonably expected. During the active fire season five inspectors from this Department were constantly engaged making examinations of the front ends and ash pans of locomotives, and, with the exception of a few instances, their equipment was found to be in fairly good condition. Naturally, our efforts in this direction have been confined to the locomotives operating wholly within the State, as

Carelessness did this.

Warning notice posted on burned-over land.

we have no control over those coming into Massachusetts from other States, where an inspection is not required. In this connection, however, I would state that through the efforts of Mr. Henry W. Seward, acting for the Department of Public Utilities, arrangements were made whereby only those locomotives known to be in perfect condition were allowed to operate in Massachusetts. Credit should be given also to Mr. Seward and his two assistants for their promptness in causing all locomotives reported as setting fires to be inspected and put in proper condition. Our records show that we have had 614 railroad fires: Boston & Albany, 114; Boston & Maine, 74; Central Vermont, 9; New York, New Haven & Hartford, 417. These fires burned over an area of 3,271 acres, causing a damage of $10,474, and costing $5,764 to extinguish.

It has been apparent for several years that the percentage of fires from unknown causes has been abnormally high. I am convinced that the secret in a large part lies in the careless use of smoking materials. For several years past our reports have placed much emphasis upon the need of educating smokers with regard to the vital importance of using caution in this respect. The rapid increase in the use of automobiles has been attended by a marked increase in the number of fires, the origin of which has been traced in most instances to the discarded cigar or cigarette thoughtlessly cast upon the roadside by the automobilist. We hope that constant agitation of this question will serve to reduce the number of these fires in the near future.

In closing, reference should be made to the continued cooperation with the Federal Department under the Weeks Law, which has been of such distinct advantage to us in the past. We view with favor the effort which is being made by the United States Forest Service to secure a greatly increased appropriation for future work of this character, which would undoubtedly result in a corresponding increase in the aid which we are receiving from this source. A tentative program has already been proposed based upon this probable increase of the government appropriation, which would provide for three additional district forest wardens, three forest fire trucks, and enable us to join with the towns in giving to forest wardens reasonable compensation for their services.

Respectfully submitted,

M. C. Hutchins,
State Fire Warden.

COMPARATIVE DAMAGES BY FOREST FIRES FOR THE PAST ELEVEN YEARS.

YEAR.	Number of Fires.	Acreage burned.	Cost to extinguish.	Damage.	Average Acreage per Fire.	Average Damage per Fire.
1910,	1,385	42,221	$23,475	$205,383	30.46	$148 20
1911,	2,356	99,693	47,093	537,749	39.31	226 24
1912,	1,851	22,072	20,219	80,834	11.92	43 67
1913,	2,688	53,826	35,456	178,357	20.02	66 35
1914,	3,181	38,975	48,750	95,389	12.25	29 98
1915,	3,008	48,389	36,783	141,073	16.08	46 90
1916,	1,425	16,198	8,593	44,765	13.22	36 54
1917,	2,175	20,020	18,033	41,109	9.21	18 90
1918,	2,553	37,638	28,043	205,627	14.74	80 05
1919,	1,566	22,045	17,388	49,069	14.07	31 32
1920,	1,619	14,517	27,839	62,241	8.96	38 44

TYPES OF CLASSIFIED DAMAGES.

	1916.	1917.	1918.	1919.	1920.
Standing trees,	$18,786	$24,705	$71,706	$16,595	$37,532
Logs, lumber, cordwood,	4,545	4,680	37,815	7,516	7,371
Buildings,	10,823	6,893	46,025	12,508	11,950
Bridges, fences,	1,638	687	1,742	902	285
Not classified,	8,973	4,144	48,339	11,548	5,103
Totals,	$44,765	$41,109	$205,627	$49,069	$62,241

Classified Causes of Forest Fires, 1915–20.

	1915.		1916.		1917.		1918.		1919.		1920.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Lightning,	–	–	–	–	–	–	–	–	–	–	–	–
Railroad,	777	25.8	412	42.1	800	36.8	799	31.2	549	35.1	614	37.9
Lumbering,	5	.1	2	.2	5	.2	14	.6	5	.3	4	.2
Brush burning,	439	14.5	79	8.1	262	12.0	300	11.7	204	13.0	155	9.6
Campers,	290	9.5	146	14.9	357	16.4	403	15.6	239	15.3	251	15.5
Incendiary,	–	–	–	–	–	–	–	–	–	–	13	.8
Miscellaneous,	363	12.4	38	3.9	117	5.4	111	4.7	70	4.5	50	3.1
Unknown,	1,134	37.7	301	30.8	634	29.2	926	36.2	499	31.8	532	32.9
Totals,	3,008	100.0	978	100.0	2,175	100.0	2,553	100.0	1,566	100.0	1,619	100.0

TYPES OF LAND BURNED OVER (ACRES).

	1916.	1917.	1918.	1919.	1920.
Timber,	1,435	1,237	2,520	1,659	1,077
Second growth,	755	2,274	5,696	2,502	1,251
Second growth, not merchantable,	1,970	4,137	6,069	2,893	2,224
Brush land,	9,990	7,126	10,549	11,122	7,119
Grass land,	1,573	3,814	4,669	3,671	2,119
Not classified,	475	1,432	8,135	198	627
Totals,	16,198	20,020	37,638	22,045	14,517

FOREST FIRES OF 1920.

MONTHS.	Number.	Acres.	Cost to extinguish.	Damage.
1919.				
December,	20	50	$62 00	$230 00
1920.				
January,	9	53	73 00	1,500 00
February,	–	–	–	–
March,	135	739	909 00	1,225 00
April,	671	5,738	4,959 00	19,049 00
May,	347	2,769	4,945 00	10,139 00
June,	66	798	990 00	1,098 00
July,	72	889	2,323 00	2,005 00
August,	40	223	1,319 00	892 00
September,	22	94	205 00	2,187 00
October,	175	2,994	11,497 00	20,571 00
November,	62	170	557 00	3,345 00
Totals,	1,619	14,517	$27,839 00	$62,341 00

TOWNS RECEIVING FIRE-EQUIPMENT REIMBURSEMENT DURING 1920.

Ashburnham,	$76 98	Millville,	$8 85
Ashland,	111 50	New Marlborough,	7 00
Avon,	17 70	Northfield,	232 97
Bellingham,	13 20	Pelham,	9 00
Bolton,	6 25	Prescott,	96 00
Boxford,	10 00	Raynham,	22 77
Cummington,	67 50	Sherborn,	48 00
Dennis,	90 25	Stow,	6 25
Erving,	96 00		
Mashpee,	16 25	Total,	$979 60
Middleton,	43 13		

REPORT OF THE SUPERINTENDENT OF GYPSY-MOTH WORK.

WILLIAM A. L. BAZELEY, *State Forester.*

SIR: — Pursuant to your request, I have the honor to submit for your information a brief report of the operations carried on against the gypsy and brown-tail moths for the fiscal year ending Nov. 30, 1920. As former annual reports and publications of this branch of the service have treated in detail of the history of the introduction of these pests into Massachusetts, their life history, and habits, I do not consider it necessary to amplify on these topics here. The manner of conducting our operations during the past year has not differed materially from that of former years. It has been our aim to employ only those methods which previous experience has shown to be most effective in reducing the insects, keeping in mind at all times the necessity of practicing wise economy. Year by year the importance of this work seems to have become more fully appreciated by the people at large, and I am happy to express the conviction that at no time during my twenty-five years' service in connection with this undertaking has there existed a more cordial spirit of co-operation on their part than has been evidenced throughout the year just closed.

GENERAL CONDITIONS.

I regret to report that, broadly speaking, the condition in the infested area of the State does not show the improvement that was hoped for. Gypsy moths have been slightly more abundant during the past season, and it is difficult for us to determine the cause of the increase. A rather puzzling phase of the situation is the fact that notwithstanding this increase in the number of caterpillars the amount of defoliation was much less than in previous years. Entomologists have advanced certain theories to account for this unusual condition, some of them contending that the frequent rains during the early part of the summer served to check the larvæ from feeding. It was also noted that the wilt disease, which in past years has been a very potent factor in killing off the caterpillars, this year failed to develop to any extent, presumably owing to climatic conditions. And finally, a partial solution of the problem may be found because of the failure since 1917 of the parasites to

operate to the best advantage, as shown in the report of Mr. A. F. Burgess, who is in charge of operations carried on against the gypsy moth by the United States Department of Agriculture, and whose report will be found on another page.

Spraying Apparatus.

The writer is pleased to state that as the importance of the moth work has become increasingly clear, most of the towns infested, responding to the recommendation of this Department, have become well equipped with modern spraying apparatus which will insure adequate protection to their shade trees, as well as enable them to give reasonable aid to the smaller property owners. Owners of many of the larger estates, emulating the example of the town, have purchased spraying equipment, and are now caring for their own property. The writer cannot urge too emphatically the wisdom of all who can do so adopting this policy.

Brown-tail Moths.

Reference was made in our report of 1919 to the reappearance of the brown-tail moth in several sections of the State. An apprehension was expressed of the danger of another serious outbreak of this damaging insect, and careful attention was given those towns where infestations occurred, and the most painstaking care used to destroy all nests. Instructions were sent to all our local moth superintendents to be extremely vigilant, and to use prompt measures to eradicate this pest whenever found. In most of the towns where infestations were discovered last year action resulted in a marked decrease. There were several instances, however, where private owners were notified of infestations on their property and instructed to fulfill the requirements of the law by removing them, which they promised to do. Subsequent investigation disclosed that they failed to act at the proper time, thus leaving a few colonies, which it is our purpose to clean up the coming season. Strict search was made for the so-called brown-tail fungous disease which heretofore has been very effective in the destruction of this insect, but in only one of the colonies was its presence discovered. I am convinced that with proper co-operation on the part of property owners a serious outbreak of this pest may be prevented, thus sparing the citizens of the Commonwealth a recurrence of the inconvenience and suffering to which they were subjected by this poisonous caterpillar a few years ago.

Cranberry Bog Work.

There has been no abatement of our efforts to protect the great Cape Cod cranberry industry against serious injury by the gypsy moth. The success which crowned our earlier efforts in this direction seems to have resulted in greater interest and renewed activity on the part of all concerned in this vitally important undertaking. Through the instrumentality of Mr. Walter F. Holmes, our Division superintendent in charge of that territory, several meetings were held during the summer for the purpose of instructing bog owners, local moth superintendents, and others with regard to the most effective methods of control. Present at some of these meetings was Dr. Franklin of the State experimental bog, who has devoted much time and study to the determination of the most effective and economical methods to apply in safeguarding cranberry bogs from insect depredations. In each instance his discussion of the subject was listened to with great interest, and was of undoubted profit to those privileged to enjoy it. Reports received from cranberry growers throughout that district were extremely encouraging, and certainly indicate that the protective measures applied in the past were fully justified by the improved conditions existing at the present time.

The Satin Moth.

Early in June the entomological world was somewhat startled by the discovery of a new insect pest in Massachusetts. This insect is known as *Stilpnotia salicis*, or the satin moth of Europe, a name undoubtedly given it because the moths are pure white and the wings have a satin-like luster. The discovery of this insect was made by Mr. A. N. Habberley, superintendent of the Middlesex Fells Reservation, near the boundary line between the cities of Malden and Medford. Specimens of the caterpillars were sent to the Gypsy Moth Laboratory at Melrose Highlands for identification, and proved to be the European species above mentioned. The fullgrown caterpillars are about one and one-half inches in length and of a yellowish color, with prominent white blotches on each segment of the back. They are very conspicuous on account of the colors, and are quite different from any caterpillars that are found in this region. European writings indicate that this species attacks poplar, willow, oak, and other trees, and occurs in many of the countries

of northern and southern Europe and eastern Asia. Investigation shows that in the infestation found here the poplar tree seems to be the favored food, although willows and other species have been attacked by the insect to some extent. There is danger, however, that if it should once become firmly established it might prove a menace to other valuable shade or forest trees.

The imperative need of the extermination of this pest was recognized, and co-operative efforts were carried on by the State Forester's office and the Metropolitan Park Commission to that end. Their efforts were directed mainly to the destruction of as many caterpillars and pupæ as possible, so as to prevent the spread of the moths into other territory. The United States Bureau of Entomology conducted scouting operations throughout the season for the purpose of determining the extent of the infestation. At the time of writing this report the presence of the moth had been noted in sixty cities and towns, its spread having extended over the line into New Hampshire.

Lynn Woods.

A striking example of what may be accomplished in protecting our woodlands from the ravages of the gypsy moth is found in the Lynn woods. This territory, comprising 2,200 acres, set aside some years ago as a public park, was at one time so heavily infested with moths as to necessitate its being closed to the public. As a result of judicious thinning, underground planting of pines, and annual spraying, supplemented by the usual methods of creosoting egg clusters, this park has been restored to a nearly normal condition.

Lumber Operations and Roadside Brush Cutting.

The discontinuance of the lumbering operations that have been practiced during the past few years as an aid to gypsy-moth suppression, the cost of supervision being paid from the gypsy-moth appropriation, enabled us to increase slightly our financial assistance to towns. This was also true with respect to the elimination of brush cutting along the roadsides. It is the opinion of the writer, however, that roadside work of this nature should be carried on in the future by towns under a special appropriation made for the purpose. A number of towns have already inaugurated that policy.

State Highway Work.

The spraying of the State highways has been done as usual under the direction of this office by the local organizations in the towns, or the traveling sprayers owned by the State, and creosoting also was done where it was recommended by our Division superintendents. The work was done in 131 municipalities at a total cost of $13,000.

Federal Gypsy-Moth Work in Massachusetts.

The Federal work of preventing the spread of the gypsy moth, conducted by the United States Bureau of Entomology under the direction of Dr. L. O. Howard, has been continued during the past year, and a brief statement covering some of the important activities in Massachusetts has been prepared by Mr. A. F. Burgess, who has charge of this work for the Bureau. His report follows: —

During the winter and early spring of 1920, scouting of the border towns west of Worcester was continued by the Bureau, and later in the spring spraying operations were carried on in several towns where heavy colonies existed, and from which long-distance spread of the insect might occur, in co-operation with the State forces. Only a limited amount of work has been done this fall on account of the small amount of funds available, but eight towns have already been found infested outside the area that was under quarantine last year. Federal field work has now been discontinued in this State on account of lack of funds, but if emergency money is quickly made available, the usual number of towns outside and adjoining the infested area will be examined before spring.

Quarantine work has been carried on as usual, all shipments of materials or products likely to carry gypsy-moth infestation having been inspected and certified before shipment is made. This work not only protects the uninfested portion of Massachusetts from this insect, but many other parts of the country that depend on eastern Massachusetts for supplies of lumber products, nursery stock and stone.

The colonization of parasites and natural enemies of the gypsy moth has been continued throughout the year, but owing to the fact that some of these beneficial insects have now become established over most of the infested area, a much smaller number of colonies have been liberated than heretofore. The work of checking up the success of colonies liberated, and the amount of parasitism that has resulted from them, has been curtailed somewhat by a combination of decrease in the amount of funds available for this work, and increase in the expense of doing it. Enough information has been secured, however, to draw some general conclusions as to the present status of the parasite situation.

As a result of the extremely severe winters of 1917–18 and 1919–20, many gypsy-moth egg clusters in exposed situations failed to hatch. This resulted in fewer caterpillars being present in the summer of 1918 and 1920 than had been anticipated, and collections made during the periods mentioned indicate that the imported parasites, particularly those that attack the eggs of the gypsy moth, suffered severe reduction in numbers.

Anastatus bifasciatus, one of the egg-attacking species, which has only a single brood, was reduced considerably in numbers, but present information indicates that it is far more abundant and widely distributed throughout the infested region than *Schedius kuwanæ*, another species that attacks gypsy-moth eggs.

The latter has been found this fall in the Cape Cod district in rather small numbers, and the result of its work during the past two or three years has been negligible in most localities on account of its inability to survive during extremely cold winter weather. The parasites which attack the caterpillars and several different species, each with different habit and mode of life, have suffered considerably from the same cause, but none have been as severely affected as Schedius.

In the summer of 1920 *Apanteles melanoscelus* was found more widely distributed in Massachusetts than ever before, and in a few localities rather heavy parasitism of the caterpillars was noted.

Compsilura concinnata, one of the Tachinid flies which attacks the gypsy-moth caterpillars, also destroys many native injurious species. It has now spread throughout the infested area, and a good percentage of parasitism resulted in many of the infested towns.

Blepharipa scutellata, a parasite of the large gypsy-moth caterpillars, has spread very rapidly during the last few years, and some collections have shown a very favorable degree of parasitism.

Conditions have been such, however, since 1917, that parasites have not operated to the best advantage. While the cold winters mentioned served to decrease the number of gypsy-moth egg clusters that hatched, they also resulted in a marked decrease in the overwintering parasites. The rate of multiplication of the gypsy moth is considerably greater than that of the parasites; hence they were not as effective this summer as might be desired. Another complication which makes the situation more difficult is that in order to bring about a reasonable amount of gypsy-moth control by action of the parasites that have already become established, it is necessary that most of the species occur in abundance and work effectively in the same locality. This does not always occur, and while egg parasites may be abundant, if their work is not supplemented by other species that attack the larvæ, it is possible for a considerable increase in gypsy-moth infestation to result.

The Calosoma beetle was not affected severely by the cold winters, and many reports were received as to its great abundance in certain localities during the past summer. While this species is able to survive in

areas where gypsy-moth infestation is light, as a rule it is more conspicuous and destructive to the gypsy moth in badly infested localities.

Brown-tail moth infestation was slightly more noticeable in 1920 than for several years prior to that time, and a number of moths were observed at arc lights in Melrose during July. The species has not been noted at lights for several years. The parasites of the brown-tail moth were less abundant than heretofore, which is doubtless partly due to the scarcity of the host.

Many lines of experimental work are under way looking toward the discovery of better and more effective methods of moth control. A co-operative project with the State of Massachusetts is being carried on in a few towns to determine the possibility of using a minimum amount of labor and hand methods, and securing the maximum amount of benefit from the parasites that are already in the field.

Special North Shore Work.

Previous reports have described in detail the gypsy-moth operations which have been conducted since 1908 in our efforts to preserve the beauty of the woods along the North Shore. This work has been carried on under a co-operative agreement whereby one-third of the expense is borne by the Commonwealth, one-third by the town of Manchester and the city of Beverly, and the remaining third provided by the North Shore residents.

The splendid condition of the forest and shade trees resulting from the protection given them is extremely gratifying, and fully justifies the expenditures. During the past season so excellent was the condition of the woodlands and roadsides that only a comparatively small portion of the tract was creosoted or sprayed.

The following figures will give some idea of the exact condition of the North Shore in general: —

Acres creosoted,	999
Acres sprayed,	694
Miles of roadside creosoted,	27
Miles of roadside sprayed,	18

Twelve miles of roadsides were so free from infestation of any kind that no work was necessary on them.

The financial statement following shows the present condition of the North Shore fund.

Special North Shore Fund.

Financial Statement.

Receipts.

Balance Dec. 1, 1919,	$3,399 16	
State Forester, credit on supplies,	223 40	
Wm. D. Sohier, agent, for work on private estates,	1,845 48	
Wm. D. Sohier, agent, collections,	5,000 00	
State Forester,	5,000 00	
Town of Manchester,	2,500 00	
City of Beverly,	2,500 00	
Massachusetts Highway Commission, for work on State highways,	201 87	
State Forester, for labor on State sprayers,	2,442 19	
State Forester, for lead furnished towns and materials on sprayers,	2,614 46	
		$25,726 56

Expenditures.

Pay roll,	$5,281 67	
Travel,	121 37	
Supplies,	886 29	
Teaming, etc.,	921 04	
Rent,	300 00	
Sundries,	6 93	
		7,517 30
Balance Nov. 30, 1920,		$18,209 26

Respectfully submitted,

George A. Smith,
Superintendent of Moth Work.

APPENDIX

APPENDIX.

FINANCIAL STATEMENT.

EXPENDITURES.

Appropriation (c. 225, Acts of 1920), salary of commissioner,	$5,000 00		
Appropriation (c. 225, Acts of 1920), personal services,	8,300 00		
Appropriation (c. 629, Acts of 1920), personal services,	250 00		
		$13,550 00	
Expenditures,		13,542 04	$13,542 04
Appropriation (c. 225, Acts of 1920), office incidentals,	$7,550 00		
Appropriation (c. 629, Acts of 1920), office incidentals,	300 00		
Refunds,	2 50		
		7,852 50	
Expenditures,		6,973 42	6,973 42
Appropriation (c. 225, Acts of 1920), general forestry and nurseries,		25,500 00	
Expenditures,		25,479 18	25,479 18
Appropriation (c. 225, Acts of 1920), purchase and planting of forest lands,		10,000 00	
Expenditures,		9,535 26	9,535 26
Appropriation (c. 225, Acts of 1920), prevention of forest fires,		45,500 00	
Expenditures,		45,000 08	45,000 08
Appropriation (c. 225, Acts of 1920), protection against forest fires,		1,500 00	
Expenditures,		979 60	979 60
Balance from 1919,	$73,679 10		
Appropriation (c. 225, Acts of 1920), suppression of gypsy and brown-tail moths,	210,000 00		
Refunds and transfers,	1,596 28		
		285,275 38	
Expenditures,		238,219 02	238,219 02
Total expenditures for 1920,			$339,728 60

RECEIPTS.

For cordwood sold,	$191 69
For trees sold,	3,285 46
For forest examinations,	70 81
For sale of land,	615 21
For refund,	2 12
For camp sites,	371 00
For rent, hay, pasturage, etc.,	913 64
For lumber, etc. (Swann Forest),	8,107 00
For supplies and gypsy-moth work,	40,073 29
For supplies for fire fighting,	1,616 97
For fire tower,	300 00
Total for year,	$55,547 19

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920.

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Abington,	$1,531 57	–	–	–	–	–	$1,697 74
Acton,	860 43	$1,232 25	$733 43[1] 103 00	$371 82	$1,321 62	$1,693 44	965 67
Acushnet,	707 91	–	–	–	–	–	1,035 66
Amesbury,	3,011 05	–	–	–	–	–	4,077 56
Amherst,	2,782 87	–	–	–	–	–	2,872 32
Andover,	3,394 96	–	–	–	–	–	4,036 03
Arlington,	5,000 00	–	–	–	–	–	5,000 00
Ashburnham,	537 91	765 46	160 50	227 55	364 08	591 63	584 69
Ashby,	296 00	666 90	425 78[1]	250 00	698 91	948 91	304 74
Ashland,	689 50	812 17	121 17[2] 81 50	122 67	972 37	1,095 04	835 00
Athol,	3,288 07	–	–	–	–	–	3,476 53
Attleboro,	5,000 00	–	–	–	–	–	5,000 00
Auburn,	865 35	239 20	80 80	–	–	–	968 96
Avon,	524 31	511 50	64 25	–	108 40	95 59	558 54
Ayer,	1,246 85	1,163 77	210 60	–	406 42	323 34	1,222 13
Barnstable,	3,693 79	–	–	–	–	–	4,072 83
Barre,	1,255 62	–	–	–	–	–	1,248 91
Bedford,	828 68	950 18	656 82[1] 1,327 94	121 50	1,094 13	1,215 63	915 33
Belchertown,	455 84	–	–	–	–	–	471 59
Bellingham,	512 92	–	–	–	–	–	610 91
Belmont,	5,000 00	–	–	–	–	–	5,000 00
Berkley,	271 22	273 67	51 05	2 45	266 72	269 17	294 29
Berlin,	268 12	610 93	137 28[1] 385 69	342 81	649 05	991 86	347 04
Beverly,	5,000 00	–	–	–	–	–	5,000 00
Billerica,	2,565 47	–	–	–	–	–	2,746 18
Blackstone,	828 87	–	–	–	–	–	850 99
Bolton,	331 89	555 95	670 47	224 06	1,501 38	1,725 44	336 91
Boston,	5,000 00	–	–	–	–	–	5,000 00
Bourne,	2,455 92	2,507 98	2,599 81	–	527 36[2]	271 89	2,500 30
Boxborough,	129 24	85 54	122 85[1] 7 50	–	1,197 46	1,153 76	140 66
Boxford,	381 90	684 07	395 09	302 17	1,143 76	1,445 93	397 64
Boylston,	236 22	712 35	534 29	476 13	538 85	1,014 98	259 72

[1] Lead sold.

[2] Includes sprayer.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Braintree,	$4,084 64	–	–	–	–	–	$4,445 23
Brewster,	324 09	$746 76	$69 32[1] 439 28	$172 67	$1,313 11[2]	$1,235 78	447 65
Bridgewater,	1,879 28	2,303 35	1,846 94	–	2,884 98[2]	2,459 98	1,901 56
Brimfield,	341 34	–	–	–	–	–	380 99
Brockton,	5,000 00	–	–	–	–	–	5,000 00
Brookfield,	681 99	–	–	–	–	–	707 44
Brookline,	5,000 00	–	–	–	–	–	5,000 00
Burlington,	459 98	674 90	292 47	214 92	643 69	858 61	569 64
Cambridge,	5,000 00	–	–	–	–	–	5,000 00
Canton,	2,437 22	–	–	–	102 16	102 16	2,750 11
Carlisle,	205 85	1,724 81	57 95[1] 829 68	1,518 96	564 84	2,083 80	233 55
Carver,	820 35	1,687 71	180 18[1] 3,406 59	867 36	2,585 44	3,452 80	849 99
Charlton,	630 43	–	–	–	–	–	655 97
Chatham,	1,000 92	1,227 69	95 50	1 77	1,066 47[2]	843 24	1,118 99
Chelmsford,	2,072 91	1,201 03	1,687 18	–	1,619 59	747 71	2,568 82
Chelsea,	5,000 00	–	–	–	–	–	5,000 00
Chilmark,	174 73	–	–	–	–	–	183 25
Clinton,	4,032 14	–	–	–	–	–	4,712 00
Cohasset,	2,619 11	–	–	–	–	–	2,674 26
Concord,	2,832 50	–	–	–	–	–	2,936 04
Dana,	205 95	–	–	–	–	–	214 84
Danvers,	3,301 50	–	–	–	–	–	3,480 12
Dartmouth,	2,463 10	–	–	–	–	–	2,959 79
Dedham,	5,000 00	–	–	–	–	–	5,000 00
Deerfield,	1,698 97	–	–	–	–	–	1,715 62
Dennis,	569 44	619 31	226 70	–	1,366 48[2]	916 35	606 97
Dighton,	1,031 64	–	–	–	–	–	1,189 45
Douglas,	587 55	–	–	–	–	–	662 69
Dover,	1,081 83	1,733 06	1,492 31	651 23	2,115 81	2,767 04	1,120 29
Dracut,	1,193 56	1,711 57	1,199 25	518 01	1,715 12	2,233 13	1,326 47
Dudley,	1,133 61	–	–	–	–	–	1,259 20
Dunstable,	163 56	623 65	395 55	460 09	719 71	1,179 80	174 19

[1] Lead sold.

[2] Includes sprayer.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Duxbury,	$1,366 25	$1,589 42	$2,575 80	$223 17	$1,477 96	$1,701 13	$1,663 03
East Bridgewater,	1,368 20	1,407 54	612 92	–	2,028 74[2]	1,818 08	1,445 79
Eastham,	214 90	554 26	78 50	114 36	911 57[2]	800 93	236 52
Easthampton,	4,319 67	–	–	–	–	–	5,000 00
Easton,	1,699 57	1,726 01	537 06	26 44	1,938 37	1,964 81	1,799 03
Edgartown,	702 98	–	–	–	–	–	718 81
Essex,	533 08	637 55	726 00	104 47	258 39	362 86	548 41
Everett,	5,000 00	–	–	–	–	–	5,000 00
Fairhaven,	2,713 65	–	–	–	–	–	3,145 65
Fall River,	5,000 00	–	–	–	–	–	5,000 00
Falmouth,	2,948 28	3,845 67	1,006 90	–	3,162 82[2]	2,568 17	3,086 10
Fitchburg,	5,000 00	–	–	–	–	–	5,000 00
Foxborough,	1,233 88	1,703 74	266 12	469 86	256 04	725 90	1,265 29
Framingham,	5,000 00	–	–	–	–	–	5,000 00
Franklin,	2,315 95	495 50	–	–	4 80	–	2,586 19
Freetown,	549 13	–	–	–	–	–	554 96
Gardner,	4,766 87	–	–	–	–	–	5,000 00
Georgetown,	564 09	1,253 95	22 09[1] 1,082 28	653 06	1,096 20	1,749 26	599 16
Gill,	262 39	–	–	–	–	–	285 04
Gloucester,	5,000 00	–	–	–	–	–	5,000 00
Grafton,	1,423 79	1,017 17	87 50	–	–	–	1,519 98
Great Barrington,	3,126 96	–	–	–	–	–	3,269 40
Greenfield,	5,000 00	–	–	–	–	–	5,000 00
Groton,	1,177 11	2,148 74	436 28[1] 1,070 40	778 25	1,050 98	1,829 23	1,278 48
Groveland,	634 83	792 89	835 95	158 06	371 08	529 14	645 72
Halifax,	325 42	1,075 06	77 19[1] 780 48	499 64	1,432 89[2]	1,682 53	376 46
Hamilton,	1,608 59	2,566 30	1,566 51	–	341 26	341 26	1,701 12
Hanover,	830 19	1,946 63	1,238 51	1,116 44	2,300 88	3,417 32	934 29
Hanson,	805 56	801 90	84 22[1] 703 37	–	724 76	721 10	834 11
Harvard,	648 24	632 96	1,184 93[1] 153 64	–	1,911 73	1,896 45	821 23
Harwich,	797 64	1,923 48	41 31[1] 412 70	1,125 84	1,167 57	2,293 41	874 76
Haverhill,	5,000 00	–	–	–	–	–	5,000 00

[1] Lead sold.

[2] Includes sprayer.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Hingham,	$2,895 96	–	–	–	–	–	$3,568 59
Holbrook,	793 69	$828 64	$477 00	–	$1,162 89	$1,162 89	854 03
Holden,	1,010 27	1,293 04	717 99	$282 77	520 98	803 75	1,020 30
Holliston,	855 52	1,522 13	224 49[1] / 774 80	666 61	614 25	1,280 86	1,031 15
Hopedale,	1,713 95	–	–	–	–	–	1,359 06
Hopkinton,	778 62	1,393 23	239 56	364 61	990 55[2]	1,105 16	839 89
Hubbardston,	352 53	–	–	–	–	–	354 30
Hudson,	2,084 97	–	–	–	6 35	–	2,330 98
Hull,	4,403 74	–	–	–	–	–	5,000 00
Ipswich,	2,382 06	2,150 60	1,610 32	–	4 47	–	2,422 77
Kingston,	674 82	1,164 24	61 89[1] / 592 75	200 00	1,048 14	1,248 14	748 79
Lakeville,	497 27	386 75	105 03[1] / 519 10	–	1,177 90	1,067 18	514 37
Lancaster,	995 43	–	–	–	–	–	1,033 70
Lawrence,	5,000 00	–	–	–	–	–	5,000 00
Leicester,	1,091 39	–	–	–	–	–	1,131 73
Lenox,	2,953 58	–	–	–	–	–	2,951 37
Leominster,	5,000 00	–	–	–	–	–	5,000 00
Lexington,	3,586 70	–	–	–	–	–	3,984 16
Leyden,	110 27	–	–	–	–	–	114 00
Lincoln,	767 42	1,790 24	1,552 76	–	1,986 21	1,986 21	802 43
Littleton,	560 69	362 20	636 00[1] / 88 75	–	1,066 63	868 14	653 39
Lowell,	5,000 00	–	–	–	–	–	5,000 00
Lunenburg,	710 59	686 62	363 33[1] / 1,429 57	–	1,281 22	1,257 25	746 25
Lynn,	5,000 00	–	–	–	–	–	5,000 00
Lynnfield,	688 55	1,854 15	615 85	1,165 60	1,396 97	2,562 57	791 71
Malden,	5,000 00	–	–	–	–	–	5,000 00
Manchester,	4,502 21	–	–	–	–	–	4,622 88
Mansfield,	2,348 21	–	–	–	–	–	2,538 48
Marblehead,	4,658 24	–	–	–	–	–	4,753 19
Marion,	1,316 29	1,722 53	1,002 75	–	2,991 75[2]	2,547 99	1,334 63
Marlborough,	4,775 32	–	–	–	–	–	5,000 00
Marshfield,	1,103 27	1,086 67	207 94[1] / 2,646 27	–	1,660 94	1,644 34	1,210 29

[1] Lead sold.

[2] Includes sprayer.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Mashpee,	$192 51	$1,779 59	$441 49	$1,587 08	$1,067 44	$2,654 52	$200 58
Mattapoisett,	768 47	–	–	–	–	–	857 31
Maynard,	1,928 70	–	–	–	–	–	2,081 30
Medfield,	861 32	581 30	33 02[1] / 591 70	135 38	1,151 04	1,286 42	883 76
Medford,	5,000 00	–	–	–	–	–	5,000 00
Medway,	812 91	–	–	–	–	–	963 06
Melrose,	5,000 00	–	–	–	–	–	5,000 00
Mendon,	309 91	–	–	–	–	–	325 14
Merrimac,	662 98	1,567 24	281 21	904 26	268 82	1,203 08	693 48
Methuen,	5,000 00	–	–	–	–	–	5,000 00
Middleborough,	2,104 62	2,997 73	165 12[1] / 1,144 26	300 00	3,044 48[2]	2,894 48	2,366 69
Middleton,	407 44	1,015 79	580 10	608 35	550 66	1,159 01	448 63
Milford,	4,250 30	–	–	–	–	–	4,823 13
Millbury,	1,483 50	–	–	–	–	–	1,750 05
Millis,	690 58	–	–	–	56 00	–	820 64
Millville,	515 79	–	–	–	–	–	531 25
Milton,	5,000 00	–	–	–	–	–	5,000 00
Monson,	826 42	–	–	–	–	–	836 12
Montague,	3,592 79	–	–	–	–	–	3,671 42
Nahant,	1,652 74	–	–	–	–	–	1,670 01
Nantucket,	2,223 16	–	–	–	–	–	2,266 05
Natick,	3,588 46	–	–	–	–	–	3,904 07
Needham,	3,960 63	–	–	–	–	–	4,386 06
New Bedford,	5,000 00	–	–	–	–	–	5,000 00
New Braintree,	193 12	–	–	–	–	–	203 83
New Salem,	216 12	–	–	–	–	–	208 94
Newbury,	629 10	1,694 51	639 52[1] / 1,020 75	1,065 41	1,180 84	2,246 25	646 81
Newburyport,	4,690 38	–	–	–	–	–	4,775 56
Newton,	5,000 00	–	–	–	–	–	5,000 00
Norfolk,	496 67	1,026 99	320 55	277 32	1,133 01[2]	1,160 33	532 17
North Andover,	2,429 85	–	–	–	80 65	–	2,564 99
No. Attleborough,	3,438 81	–	–	–	–	–	3,453 37

[1] Lead sold.

[2] Includes sprayer.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
North Brookfield,	$860 17	–	–	–	–	–	$878 56
North Reading,	463 97	$1,126 57	$549 10	$662 60	$1,411 00	$2,073 60	607 14
Northborough,	778 43	1,713 13	206 24[1] / 915 08	934 70	1,243 90	2,178 60	818 66
Northbridge,	2,236 20	–	–	–	–	–	2,403 45
Norton,	777 91	1,736 02	215 93	708 11	1,182 12[2]	1,640 23	829 38
Norwell,	515 29	1,336 10	1,205 49	570 81	2,500 64[3]	2,821 45	536 57
Norwood,	5,000 00	–	–	–	–	–	5,000 00
Oak Bluffs,	918 68	–	–	–	–	–	1,049 83
Oakham,	173 40	–	–	–	–	–	176 12
Orange,	1,748 65	–	–	–	–	–	1,847 72
Orleans,	531 68	956 81	723 72	200 13	1,214 99[3]	1,190 12	656 77
Oxford,	941 56	–	–	–	–	–	977 12
Palmer,	2,841 65	–	–	–	–	–	3,873 48
Paxton,	169 77	–	–	–	–	–	195 45
Peabody,	5,000 00	–	–	–	–	–	5,000 00
Pembroke,	551 66	2,458 71	1,108 29	1,907 05	2,831 38	4,738 43	579 63
Pepperell,	1,021 54	1,373 73	125 23[1] / 579 16	352 16	1,388 81	1,741 00	1,089 29
Petersham,	446 59	–	–	–	–	–	554 23
Phillipston,	136 61	–	–	–	–	–	139 40
Plainville,	512 57	1,092 53	105 35	589 96	524 86	1,114 82	478 75
Plymouth,	5,000 00	–	–	–	–	–	5,000 00
Plympton,	207 03	1,225 28	138 65	1,018 25	645 74	1,663 99	228 27
Princeton,	452 54	1,179 63	104 14[1] / 113 14	727 09	748 31	1,475 40	447 53
Provincetown,	1,355 58	–	–	–	–	–	1,525 04
Quincy,	5,000 00	–	–	–	–	–	5,000 00
Randolph,	1,161 62	–	–	–	–	–	1,213 68
Raynham,	526 22	638 25	35 00[3] / 407 96	–	1,184 89[3]	934 89	546 64
Reading,	3,277 45	–	–	–	–	–	3,686 12
Rehoboth,	471 94	–	–	–	–	–	699 15
Revere,	5,000 00	–	–	–	–	–	5,000 00
Rochester,	452 87	887 51	349 50	184 64	1,117 03[3]	1,051 67	469 17
Rockland,	2,277 72	–	–	–	–	–	2,652 94

[1] Lead sold. [2] Includes sprayer. [3] Supplies sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Rockport,	$1,772 64	–	–	–	–	–	$1,818 11
Rowley,	413 22	$1,038 08	$737 20[1] 753 12	$624 86	$1,212 53	$1,837 39	439 21
Royalston,	380 60	–	–	–	–	–	401 07
Rutland,	431 15	–	–	–	–	–	430 08
Salem,	5,000 00	–	–	–	–	–	5,000 00
Salisbury,	811 89	1,005 81	877 53	193 92	985 29	1,179 21	933 88
Sandwich,	586 67	1,609 39	511 71 768 89	1,022 72	1,303 29	2,326 01	636 93
Saugus,	3,206 92	–	–	–	–	–	3,385 72
Scituate,	2,533 41	–	–	–	–	–	2,923 87
Seekonk,	979 24	–	–	–	–	–	1,019 04
Sharon,	1,442 26	1,736 53	552 21	294 27	–	294 27	1,531 69
Sherborn,	669 14	3,256 74	269 44[1] 1,634 48	2,187 60[2]	1,393 17	3,580 77	704 35
Shirley,	654 26	718 58	15 00[1] 260 56	64 29	853 32	917 61	785 83
Shrewsbury,	1,658 05	1,489 87	845 98	–	1,083 36	915 18	1,839 37
Somerset,	957 17	–	–	–	–	–	1,154 47
Somerville,	5,000 00	–	–	–	–	–	5,000 00
South Hadley,	2,157 74	–	–	–	–	–	2,206 78
Southborough,	893 45	1,894 71	1,394 84	1,001 26	1,149 19	2,150 45	953 14
Spencer,	1,458 37	–	–	–	–	–	1,524 52
Springfield,	5,000 00	–	–	–	–	–	5,000 00
Sterling,	579 03	436 09	353 16[1] 146 50	–	684 17	513 23	596 82
Stockbridge,	1,879 94	–	–	–	–	–	2,298 32
Stoneham,	2,975 59	–	–	–	–	–	2,960 59
Stoughton,	2,400 19	–	–	–	7 49	–	2,346 88
Stow,	462 51	578 44	674 75[1] 504 20	115 93	954 93	1,070 86	632 89
Sturbridge,	428 93	–	–	–	–	–	438 90
Sudbury,	580 10	572 43	846 30[1] 325 22	–	1,474 50	1,466 83	603 44
Sutton,	665 65	–	–	–	–	–	677 30
Swampscott,	5,000 00	–	–	–	–	–	5,000 00
Swansea,	772 03	–	–	–	–	–	846 63
Taunton,	5,000 00	–	–	–	–	–	5,000 00

[1] Lead sold.

[2] Sherborn bought sprayer for $800, and agreed to pay one-half cost in addition to liability.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Continued.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Templeton,	$1,133 84	$766 23	$81 00[1] 290 50	–	$437 83	$70 22	$1,038 80
Tewksbury,	1,099 64	2,451 27	751 29	$1,351 63	1,931 86	3,283 49	1,156 15
Tisbury,	866 55	–	–	–	–	–	971 27
Topsfield,	943 41	1,292 63	395 97	349 22	224 92	574 14	944 94
Townsend,	569 79	1,222 74	1,025 35	652 95	654 02	1,306 97	828 04
Truro,	253 08	455 62	81 00	202 54	273 81	476 35	260 26
Tyngsborough,	374 33	3,494 02	1,661 94	2,337 29	1,273 01	3,610 30	377 27
Upton,	546 86	–	–	–	–	–	593 18
Uxbridge,	1,971 59	–	–	–	–	–	2,497 94
Wakefield,	5,000 00	–	–	–	–	–	5,000 00
Wales,	134 49	–	–	–	–	–	145 14
Walpole,	2,964 11	–	–	–	–	–	3,243 93
Waltham,	5,000 00	–	–	–	–	–	5,000 00
Ware,	2,519 09	–	–	–	–	–	2,638 46
Wareham,	2,733 90	2,971 06	1,005 00	–	3,066 91[2]	2,388 26	3,298 73
Warren,	1,180 40	–	–	–	–	–	1,530 20
Warwick,	181 97	–	–	–	–	–	188 82
Watertown,	5,000 00	–	–	–	–	–	5,000 00
Wayland,	1,047 18	660 45	107 94[1] 1,126 81	–	1,693 64	1,306 91	1,207 28
Webster,	2,685 05	–	–	–	–	–	4,147 65
Wellesley,	5,000 00	–	–	–	–	–	5,000 00
Wellfleet,	332 37	641 37	138 30	359 00	406 22	765 22	351 88
Wendell,	275 34	–	–	–	–	–	266 69
Wenham,	906 25	798 74	347 10	–	820 65	713 14	1,083 36
West Boylston,	452 68	524 04	191 21[1] 542 25	71 36	700 22	771 58	512 68
West Bridgewater,	793 08	1,466 18	670 00	673 10	1,204 45	1,877 55	833 36
West Newbury,	416 02	707 19	660 43	291 17	593 48	884 65	434 48
West Tisbury,	228 49	–	–	–	–	–	240 07
Westborough,	1,361 57	2,324 18	994 66	962 61	888 90	1,851 51	1,485 20
Westford,	994 99	1,090 51	400 00[1] 1,068 82	95 52	1,265 71	1,361 23	1,099 63
Westminster,	465 59	665 93	257 80	200 34	407 43	607 77	462 83
Weston,	2,054 91	4,148 87	611 40	–	3,092 75	3,092 75	2,164 52

[1] Lead sold.

[2] Includes sprayer.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS TO TOWNS AND CITIES FOR THE YEAR 1920 — *Concluded.*

CITIES AND TOWNS.	1920.						1921.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Westport, . .	$1,239 29	–	–	–	–	–	$1,855 17
Westwood, . .	1,026 17	–	–	–	–	–	1,105 05
Weymouth, . .	5,000 00	–	–	–	–	–	5,000 00
Whitman, . .	2,339 37	–	–	–	–	–	2,505 83
Wilmington, . .	888 55	$2,261 31	$1,016 43	$1,082 76	$1,888 68	$2,971 44	977 02
Winchendon, . .	1,857 80	1,114 40	506 40	–	248 55	–	1,954 55
Winchester, . .	5,000 00	–	–	–	–	–	5,000 00
Winthrop, . .	5,000 00	–	–	–	–	–	5,000 00
Woburn, . .	5,000 00	–	–	–	–	–	5,000 00
Worcester, . .	5,000 00	–	–	–	–	–	5,000 00
Wrentham, . .	728 94	–	–	–	–	–	763 53
Yarmouth, . .	788 52	1,395 11	221 79	606 59	766 27	1,372 86	810 56

The Distribution of Supplies.

Supplies, including arsenate of lead and hose, have been furnished to towns and cities doing gypsy-moth work, as usual. The amounts given in the list below do not always correspond exactly with the aid given the towns, as some towns make payments to the State for all or a part of the bill for supplies, according to the amount of their net expenditure or their class, under the provisions of chapter 381, Acts of 1905.

For amounts received from this office in reimbursement and for expenditures, see table on page 64.

List of Cities and Towns and Amounts of Supplies furnished for 1920.

Acton,	$1,321 62	Groveland,	$371 08
Ashburnham,	364 08	Halifax,	1,432 89[1]
Ashby,	698 91	Hamilton,	341 26
Ashland,	972 37	Hanover,	2,300 88
Avon,	108 40	Hanson,	724 76
Ayer,	406 42	Harvard,	1,911 73
Bedford,	1,094 13	Harwich,	1,167 57
Berlin,	649 05	Holbrook,	1,162 89
Bolton,	1,501 38	Holden,	520 98
Bourne,	527 36[1]	Holliston,	614 25
Boxborough,	1,197 46	Hopkinton,	990 55[1]
Boxford,	1,143 76	Hudson,	6 35
Boylston,	538 85	Ipswich,	4 47
Brewster,	1,313 11[1]	Kingston,	1,048 14
Bridgewater,	2,884 98[1]	Lakeville,	1,177 90
Burlington,	643 69	Lincoln,	1,986 21
Canton,	102 16	Lunenburg,	1,281 22
Carlisle,	564 84	Lynnfield,	1,396 97
Carver,	2,559 44	Marion,	2,991 75[1]
Chatham,	1,066 47[1]	Marshfield,	1,660 94
Chelmsford,	1,619 59	Mashpee,	1,067 44
Dennis,	1,366 48[1]	Medfield,	1,151 04
Dover,	2,115 81	Merrimac,	298 82
Dracut,	1,715 12	Middleborough,	3,044 48[1]
Dunstable,	719 71	Middleton,	550 66
Duxbury,	1,477 96	Millis,	56 00
East Bridgewater,	2,028 74[1]	Newbury,	1,180 84
Eastham,	911 57[1]	Norfolk,	1,133 01[1]
Easton,	1,938 37	North Andover,	80 65
Essex,	258 39	North Reading,	1,411 00
Falmouth,	3,162 82[1]	Northborough,	1,243 90
Foxborough,	256 04	Norton,	1,182 12[1]
Franklin,	4 80	Norwell,	2,500 64[1]
Georgetown,	1,096 20	Orleans,	1,214 99[1]
Groton,	1,050 98	Pembroke,	2,831 38

[1] This includes cost of sprayer.

LIST OF CITIES AND TOWNS AND AMOUNTS OF SUPPLIES FURNISHED FOR 1920 — *Concluded.*

Pepperell,	$1,388 81	Townsend,	$654 02
Plainville,	524 86	Truro,	273 81
Plympton,	645 74	Tyngsborough,	1,273 01
Princeton,	748 31	Wareham,	3,066 91[1]
Raynham,	1,184 89[1]	Wayland,	1,693 64
Rochester,	1,117 03[1]	Wellfleet,	406 22
Rowley,	1,212 53	Wenham,	820 65
Salisbury,	985 29	West Boylston,	700 22
Sandwich,	1,303 29	West Bridgewater,	1,204 45
Sherborn,	2,193 17[1]	West Newbury,	593 48
Shirley,	853 32	Westborough,	888 90
Shrewsbury,	1,083 36	Westford,	1,265 71
Southborough,	1,149 19	Westminster,	407 43
Sterling,	684 17	Weston,	3,092 75
Stoughton,	7 49	Wilmington,	1,888 68
Stow,	954 93	Winchendon,	248 55
Sudbury,	1,474 50	Yarmouth,	766 27
Templeton,	437 83		
Tewksbury,	1,931 86		$120,771 01
Topsfield,	224 92		

General forestry and nurseries,	$191 80
Maintenance of forests,	120 96
Maintenance of Swann Forest,	26 65
Prevention of forest fires,	185 61
Massachusetts Highway Commission,	1,316 46
Special North Shore fund,	33 95
Purchase and development of State forests,	111 90
	$1,987 33

STATEMENT OF EXPENDITURES AND RECEIPTS ON STATE FORESTS FOR THE YEAR ENDING NOV. 30, 1920.

State Forest.	Expenses.					Receipts.
	Planting.	General Upkeep, Fire Lines, Roads, etc.	Nursery.	Land.	Total.	
Arthur Warton Swann,	$462 00	$464 01	-	-	$926 01	$591 12
Harold Parker,	1,405 46	1,415 78	-	$623 00	3,444 24	11 25
Myles Standish,	3,942 39	3,271 54	$312 98	-	7,526 91	580 52
Otter River,	1,535 19	990 93	107 74	14 63	2,648 49	62 36
Savoy Mountain,	1,544 82	332 44	672 40	1,000 00	3,549 66	90 00
Totals,	$8,889 86	$6,474 70	$1,093 12	$1,637 63	$18,095 31	$1,335 27

[1] This includes cost of sprayer.

List of Forest Wardens and Local Moth Superintendents.

[Alphabetically by towns and cities.]

Telephone Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
398-R,	J. H. Mackins,	Abington,	C. F. Shaw,	5
71-4, West Acton,	Wm. H. Kingsley,	Acton,	J. O'Neil,	2
2003-M,	Henry F. Taber,	Actushnet,	A. P. R. Gilmore,	4
383-J,	Edgar A. Deyette,	Adams,	Edgar A. Deyette,	6
6465-M, River,	-	Agawam,	E. M. Hitchcock,	6
161-6,	Wm. F. Milligan,	Alford,	-	-
-	Jas. E. Feltham,	Amesbury,	Joseph Merrill,	3
483-J,	A. F. Bardwell,	Amherst,	W. H. Smith,	6
212,	Lester Hilton,	Andover,	Edw. H. Berry,	3
35 and 206,	W. H. Pierce,	Arlington,	Daniel M. Daley,	2
5-12,	C. H. Billings,	Ashburnham,	Chas. H. Pratt,	2
22-5 and 2-3,	Wm. S. Green,	Ashby,	Carl H. Houghton,	2
3-5,	Ralph Tredick,	Ashfield,	-	6
546-M,	Chester MacNear,	Ashland,	Theodore P. Hall,	2
-	Frank P. Hall,	Athol,	George A. Whitney,	6
34-R-4,	H. R. Packard,	Attleboro,	W. E. S. Smith,	4
5-12,	J. F. Searle,	Auburn,	J. F. Searle,	6
2967-J, Brockton,	Chas. S. Wheeler,	Avon,	W. W. Beals,	4
306-3,	D. C. Smith,	Ayer,	D. C. Smith,	2
-	Zebina H. Jenkins,	Barnstable,	Robert Cross,	5
83-4,	A. E. Traver,	Barre,	Jas. A. Dwinnell,	6
8000 and 18,	P. B. McCormick,	Becket,	-	-
498-W, Lexington,	Irving C. Waite,	Bedford,	W. A. Cutler,	3
31-3,	Herbert F. Shaw,	Belchertown,	E. C. Howard,	6
8639-2, Milford,	L. F. Thayer,	Bellingham,	Lewis E. Whitney,	4
409-W,	J. F. Leonard,	Belmont,	Martin Troy,	2
1443-R,	Gideon H. Babbitt,	Berkley,	A. A. Briggs,	4
17-2,	Forrest E. Day,	Berlin,	C. A. Howe,	2
43-3,	Thurman H. Keet,	Bernardston,	Edwin B. Hale,	6
2-0,	Robert H. Grant,	Beverly,	Jas. W. Blackmer,	1
22-4 and 22-5,	E. N. Bartlett,	Billerica,	Francis J. Dolan,	3
-	John H. Dwyer,	Blackstone,	A. J. Duggan,	6
16-3,	I. E. Whitney,	Blandford,	-	-
3-3,	Albert I. Pardee,	Bolton,	C. E. Mace,	2
-	-	Boston,	Wm. P. Long,	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
38 and 44-3,	W. E. R. Nye,	Bourne,	Edw. D. Nickerson,	5
102-2, West Acton,	H. J. Livermore,	Boxborough,	S. D. Salmon, 3d,	2
19-31, Topsfield,	Clarence E. Brown,	Boxford,	C. Perley,	3
29-2,	John N. Flagg,	Boylston,	Walter G. Brigham,	6
– –	James M. Cutting,	Braintree,	Wm. J. McCusker,	4
76-23,	T. B. Tubman,	Brewster,	Abbott N. Baker,	5
281-3,	F. C. Worthen,	Bridgewater,	F. C. Worthen,	5
18-2,	Geo. E. Hitchcock,	Brimfield,	Frank G. Hitchcock,	6
Fire Department,	Edw. F. Dahill,	Brockton,	Rufus H. Carr,	5
101-3,	P. E. Gadaire,	Brookfield,	J. H. Conant,	6
– –	Geo. H. Johnson,	Brookline,	Ernest B. Dane,	1
15-4,	Walter W. Skelton,	Burlington,	Walter W. Skelton,	3
52-8,	Gilbert E. Griswold,	Buckland,	– –	–
– –	– –	Cambridge,	J. F. Donnelly,	2
– –	Edward Healy,	Canton,	Wm. H. Gallivan,	4
76-M, Concord,	Geo. G. Wilkins,	Carlisle,	Geo. G. Wilkins,	3
27-22,	James S. McKay,	Carver,	James S. McKay,	5
14-12,	Albert L. Veber,	Charlemont,	– –	–
42-2,	E. A. Lamb,	Charlton,	Thos. Ashworth,	6
28-3,	Geo. W. Ryder,	Chatham,	Richard G. Luard,	5
– –	Arnold C. Perham,	Chelmsford,	Walter Shepard,	3
– –	– –	Chelsea,	J. A. O'Brien,	1
285-M,	Daniel L. Wood,	Cheshire,	– –	–
– –	Wm. H. Babb,	Chester,	– –	–
8-2,	Wm. H. Baker, Jr.,	Chesterfield,	– –	–
149-M,	John E. Pomphret,	Chicopee,	Edw. Bourbeau,	6
– –	Robert W. Vincent,	Chilmark,	Almon S. Tilton,	5
485-X,	A. G. Caswell,	Clarksburg,	B. F. Eddy,	6
312-W,	Andrew J. Robinson,	Clinton,	Peter R. Gibbons,	2
260,	Wm. J. Brennock,	Cohasset,	George Young,	5
23-2,	Frank A. Walden,	Colrain,	E. F. Copeland,	6
438-M,	Harry E. Tuttle,	Concord,	H. P. Richardson,	2
– –	Edgar Jones,	Conway,	– –	–
41-2,	W. F. Mansell,	Cummington,	– –	–
81-J,	S. L. Cæsar,	Dalton,	– –	–
– –	Leroy H. Thayer,	Dana,	Thos. L. Thayer,	6
– –	Michael H. Barry,	Danvers,	T. E. Tinsley,	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
1658-5,	Chas. H. Mead,	Dartmouth,	E. M. Munson,	4
373-38, Rock,	H. J. Harrigan,	Dedham,	J. T. Kennedy,	4
273-22, Greenfield,	Wm. L. Harris,	Deerfield,	Wm. L. Harris,	6
8118-4,	Chas. E. Pierce,	Dennis,	Chas. E. Pierce,	5
29-3,	Ralph Earle,	Dighton,	Albert N. Goff,	4
11-4,	Wm. L. Church,	Douglas,	F. J. Libby,	6
38-2,	Geo. W. Armstrong,	Dover,	H. L. MacKenzie,	4
– –	Frank H. Gunther,	Dracut,	T. F. Carrick,	3
423-R,	F. A. Putnam,	Dudley,	Herbert J. Hill,	6
5-11,	Archie W. Swallow,	Dunstable,	W. H. Savill,	2
82-2,	H. E. Merry,	Duxbury,	John D. Morrison,	5
– –	M. F. Roach,	East Bridgewater,	Allan B. Shaw,	5
– –	– –	E. Longmeadow,	Herman W. King,	6
24-3,	Adin L. Gill,	Eastham,	Wm. B. Higgins,	5
365-3,	John M. Dineen,	Easthampton,	Chas. Kuhfuss,	6
225-3,	Daniel Lorden,	Easton,	R. W. Melendy,	4
241-2,	Manuel Swartz,	Edgartown,	John P. Fuller,	5
165-25,	Frank Bradford,	Egremont,	– –	–
31-21,	Clinton Powell,	Enfield,	H. C. Moore,	6
– –	Charles H. Holmes,	Erving,	C. H. Holmes,	6
51-3,	Otis O. Story,	Essex,	Otis O. Story,	1
– –	– –	Everett,	Dana Hanson,	2
1686-Y,	Chas. F. Benson,	Fairhaven,	G. W. King,	4
822-W,	Wm. Stevenson,	Fall River,	Wm. Stevenson,	4
136-2,	Herbert H. Lawrence,	Falmouth,	W. W. Eldridge, Jr.,	5
745,	Guy A. Hubbard,	Fitchburg,	Guy A. Hubbard,	2
9417-3, Hoosac Tunnel pay station.	H. B. Brown,	Florida,	– –	–
131 and 76,	Ernest A. White,	Foxborough,	C. W. Parkhurst,	4
352-4,	B. P. Winch,	Framingham,	N. I. Bowditch,	4
149-R,	Ernest L. Metcalf,	Franklin,	J. W. Stobbart,	4
19-3,	Oscar M. Hanson,	Freetown,	G. M. Nichols,	4
191-161,	Geo. S. Hodgman,	Gardner,	Chas. J. Crabtree,	6
– –	Nelson Francis,	Gay Head,	Nelson A. Francis,	5
– –	Leslie P. Merrill,	Georgetown,	Jacob Hazen,	3
222-12,	Lewis C. Munn,	Gill,	Warren R. Purple,	6
2102-M,	Harland W. Dann,	Gloucester,	Harland W. Dann,	6

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
18-16,	Frank Rice,	Goshen,	– –	–
– –	Frederick A. Veeder,	Gosnold,	– –	–
18-2,	E. E. Sibley,	Grafton,	C. K. Despeau,	6
– –	Chas. N. Rust,	Granby,	George A. Harris,	6
5-13,	Albert C. Sheets,	Granville,	– –	–
327,	D. W. Flynn,	Great Barrington.	Daniel W. Flynn,	6
1185,	John W. Bragg,	Greenfield,	John W. Bragg,	6
– –	Wm. H. Walker,	Greenwich,	Thos. Severance, Jr.,	6
– –	A. A. Wood,	Groton,	Shadrach Evans,	2
929-M, Haverhill,	Geo. L. Nelson,	Groveland,	R. D. Larive,	3
651-33,	Edward P. West,	Hadley,	Leroy C. Savin,	6
5-21 and 33-33, Bryantville.	Geo. H. Armstrong,	Halifax,	John A. Wood,	5
– –	Fred Berry,	Hamilton,	Harry R. McGregor,	1
– –	John Swenson,	Hampden,	– –	–
– –	Alfred Rathbone,	Hancock,	– –	–
441-W, Rockland,	Louis E. Stone,	Hanover,	Chas. B. Drew,	5
12-23, Bryantville,	Geo. T. Moore,	Hanson,	George T. Moore,	5
43-12,	George J. Fay,	Hardwick,	George J. Fay,	6
63-3,	Geo. C. Maynard,	Harvard,	Geo. C. Maynard,	2
8-2 and 23-4,	John Condon,	Harwich,	Arthur F. Cahoon,	5
72-4,	Fred T. Bardwell,	Hatfield,	Seth W. Kingsley,	6
Fire station,	John B. Gordon,	Haverhill,	M. J. Fitzgerald,	3
17-7,	Herbert A. Holden,	Hawley,	– –	–
5-18,	S. G. Benson,	Heath,	– –	–
570 and 344-M,	William L. Howard,	Hingham,	T. L. Murphy,	5
33-12,	Alfred N. Warren,	Hinsdale,	– –	–
– –	Melvin L. Coulter,	Holbrook,	Frederick W. Whitcomb.	4
42-4,	Winfred H. Stearns,	Holden,	Winfred H. Stearns,	6
5-21,	Oliver L. Howlett,	Holland,	Arthur F. Blodgett,	6
113 and 46-3,	Waldo A. Collins,	Holliston,	Herbert E. Jones,	2
– –	C. J. Haley,	Holyoke,	John F. Kennedy,	6
248-W,	Samuel E. Kellogg,	Hopedale,	C. E. Nutting,	6
19,	George W. Smith,	Hopkinton,	W. A. Macmillan,	6
8040,	A. E. Bennett,	Hubbardston,	Chas. P. Wyman,	6
24 and 199-J,	M. P. Mitchell,	Hudson,	T. J. Higgins,	2
– –	– –	Hull,	John F. Smith,	5
4-11,	John J. Kirby,	Huntington,	– –	–

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
137-R and 135-2,	Thos. R. Roberts,	Ipswich,	Francis C. Wade,	1
103,	Roland Bailey,	Kingston,	Chas. H. Childs,	5
261-W, Middleborough.	N. F. Washburn,	Lakeville,	Leavitt C. Caswell,	5
- -	Arthur W. Blood,	Lancaster,	L. R. Griswold,	2
- -	King D. Keeler,	Lanesborough,	- -	-
805-362 and 3610,	Francis J. Morris,	Lawrence,	John H. Brown,	3
- -	James W. Bossidy,	Lee,	- -	-
35-3, Leicester,	John A. Fitzpatrick,	Leicester,	J. H. Woodhead,	6
- -	Oscar R. Hutchinson,	Lenox,	Wheeler A. Shepardson.	6
28, 29 and 546,	Fred A. Russell,	Leominster,	D. E. Bassett,	2
9-25,	Fred L. Morrison,	Leverett,	I. H. Taylor,	6
480,	Osborne J. Gorman,	Lexington,	Osborne J. Gorman,	3
284-41,	A. G. Parks,	Leyden,	Jacob Sauter,	6
44-W,	John J. Kelliher,	Lincoln,	John J. Kelliher,	2
17-4,	A. E. Hopkins,	Littleton,	A. E. Hopkins,	2
6375-J, River,	Oscar C. Pomeroy,	Longmeadow,	- -	-
3400,	Edward F. Saunders,	Lowell,	J. G. Gordon,	3
1-12,	Henry A. Munsing,	Ludlow,	Ashley M. Bucher,	6
20,	James S. Gilchrest,	Lunenburg,	J. S. Gilchrest,	2
- -	John P. Morrissey,	Lynn,	John P. Morrissey,	1
3682-M, Lynn,	F. C. Newhall,	Lynnfield,	L. H. Twiss,	1
- -	Watson B. Gould,	Malden,	Watson B. Gould,	2
319-W,	Peter A. Sheahan,	Manchester,	Peter A. Sheahan,	1
1-R, 281-W and 1-W.	Herbert E. King,	Mansfield,	Alexander Murphy,	4
355,	John T. Adams,	Marblehead,	W. H. Stevens,	1
117-2,	George B. Nye,	Marion,	J. Allenach,	5
- -	- -	Marlborough,	M. E. Lyons,	2
43-3,	William G. Ford,	Marshfield,	P. R. Livermore,	5
31-2, Cotuit,	Darius C. Coombs,	Mashpee,	S. H. Peters,	5
52-5,	Chas. T. Dexter,	Mattapoisett,	John S. Hammond,	5
115-4 and 72,	Geo. H. Gutteredge,	Maynard,	John F. Cleary,	2
- -	Lawrence M. Dewar,	Medfield,	G. L. L. Allen,	4
138,	Thomas A. Qualey,	Medford,	Hugh G. Kennedy,	2
6-2,	John B. Durfee,	Medway,	F. Hagar,	4
- -	- -	Melrose,	J. J. McCullough,	3
- -	Carl M. Taft,	Mendon,	F. M. Aldrich,	6
3-5,	Chas. R. Ford,	Merrimac,	Chas. R. Ford,	3

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
229, Lawrence,	Thomas Dow,	Methuen,	A. H. Wagland,	3
76-Y,	John J. Fowler, Jr.,	Middleborough,	John J. Fowler, Jr.,	5
8000,	George E. Cook,	Middlefield,	– –	–
475-16, Danvers,	Thos. M. Robinson,	Middleton,	B. T. McGlauflin,	1
37-M,	Edward J. Burke,	Milford,	P. F. Fitzgerald,	6
259,	Harry L. Snelling,	Millbury,	E. F. Roach,	6
73,	Chas. LaCroix,	Millis,	Everett L. Coldwell,	4
1149-J-1, Woonsocket.	Robert A. McLaughlin,	Millville,	Andrew J. Gibbons,	6
1022-W,	Ralph S. Carpenter,	Milton,	Ralph E. Forbes,	4
13-13,	Edw. C. David,	Monroe,	– –	–
12-22,	O. E. Bradway,	Monson,	Robert S. Fay,	6
14-4,	Thomas Berard,	Montague,	F. B. Gillette,	6
401-43,	Jasper H. Bills,	Monterey,	– –	–
3-24, Russell,	Andrew J. Hall,	Montgomery,	– –	–
17-6,	Howard Porter,	Mount Washington.	– –	–
– –	– –	Nahant,	Herbert Coles,	1
16-3,	E. W. Francis,	Nantucket,	W. M. Voorneveld,	5
– –	John H. Neary,	Natick,	Jesse E. Wight,	2
142,	H. Howard Upham,	Needham,	George Twigg,	4
– –	Chas. S. Baker,	New Ashford,	– –	–
2280,	Edward F. Dahill,	New Bedford,	C. F. Lawton,	4
6-4, Gilbertville,	Frank A. Morse,	New Braintree,	E. L. Havens,	6
13-6,	Edward M. Stanton,	New Marlborough.	– –	–
113-5, Cooleyville,	Frank L. Hamilton,	New Salem,	Frank Hamilton,	6
1112-5,	Wm. P. Bailey,	Newbury,	Percy Oliver,	3
380,	Charles P. Kelley,	Newburyport,	Chas. P. Kelley,	3
30, Center Newton,	Walter B. Randlett,	Newton,	Chas. Benyon,	2
41-13,	Stephen Watson,	Norfolk,	J. Albert Buckley,	4
205-W,	H. J. Montgomery,	North Adams,	Jackson L. Temple,	6
1029-J,	Wm. L. Smith,	North Andover,	Wm. L. Smith,	3
– –	Harry W. Tufts,	North Attleborough.	F. P. Toner,	4
63-4,	Oscar C. Hirbour,	North Brookfield,	S. B. Colburn,	6
– –	George E. Eaton,	North Reading,	George E. Eaton,	3
165,	John F. Marlowe,	Northampton,	Chas. A. Maynard,	6
11,	Frank Gates,	Northborough,	T. P. Haskell,	6
180 and 71-5,	W. E. Burnap,	Northbridge,	A. F. Whitin,	6
114-2,	Fred W. Doane,	Northfield,	Fred W. Doane,	6

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
18-11,	George H. Storer,	Norton,	Solomon C. Haskell,	4
43-3,	John T. Osborn,	Norwell,	Fred M. Curtis,	5
417-M,	Frank W. Talbot,	Norwood,	Wm. P. Hammersley,	4
241-12,	George A. Smith,	Oak Bluffs,	D. J. McBride,	5
17-5,	C. H. Trowbridge,	Oakham,	C. H. Trowbridge,	6
18-3,	William Walsh,	Orange,	Elbridge S. Blodgett,	6
33-2,	James Boland,	Orleans,	A. Smith,	5
– –	Albert H. Spencer,	Otis,	– –	–
2-4,	Arthur A. Allen,	Oxford,	Eugene Wetherell,	6
53-W and 53-R,	James Summers,	Palmer,	Arthur F. Bennett,	6
881-R, Cedar,	Henry H. Pike,	Paxton,	H. S. Robinson,	6
– –	John J. Callahan,	Peabody,	J. J. Callahan,	1
5-W,	John H. Hubbard,	Pelham,	Leigh Weaver,	6
83-3, Bryantville, 8015-4, Hanover.	J. J. Shepherd,	Pembroke,	Wm. C. Jones,	5
23-21,	G. M. Palmer,	Pepperell,	John Tune,	2
– –	Walter H. Pike,	Peru,	– –	–
61,	George Marsh,	Petersham,	Daniel Broderick,	6
176-6,	W. H. Cowlbeck,	Phillipston,	Wm. H. Cowlbeck,	6
535-M,	Chas. L. Klein,	Pittsfield,	– –	–
67-6,	E. H. Nye,	Plainfield,	– –	–
226-J,	Frank V. Herrick,	Plainville,	George H. Snell,	4
264,	Ira C. Ward,	Plymouth,	A. A. Raymond,	5
13-7, Kingston,	David L. Bricknell,	Plympton,	David L. Bricknell,	5
19-4, Cooleyville,	Fred W. Doubleday,	Prescott,	C. M. Pierce,	6
13-4,	Fred W. Bryant,	Princeton,	F. A. Skinner,	6
129-11,	James H. Barnett,	Provincetown,	F. G. Hill,	5
6,	Alfred L. Mead,	Quincy,	A. J. Stewart,	4
– –	– –	Randolph,	John F. Moore,	4
1263-M,	J. C. Williams,	Raynham,	G. M. Leach,	4
430,	Orville O. Ordway,	Reading,	H. M. Donegan,	3
11-12,	B. F. Munroe,	Rehoboth,	Chas. B. Douglas,	4
– –	– –	Revere,	Herbert T. White,	1
8-2,	Timothy B. Salmon,	Richmond,	– –	–
12-32,	Daniel E. Hartley,	Rochester,	Samuel H. Corse,	5
55-X,	John H. Burke,	Rockland,	F. H. Shaw,	5
14-4,	John C. Martin,	Rockport,	F. A. Babcock,	1
21-6,	Merritt A. Peck,	Rowe,	– –	–

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

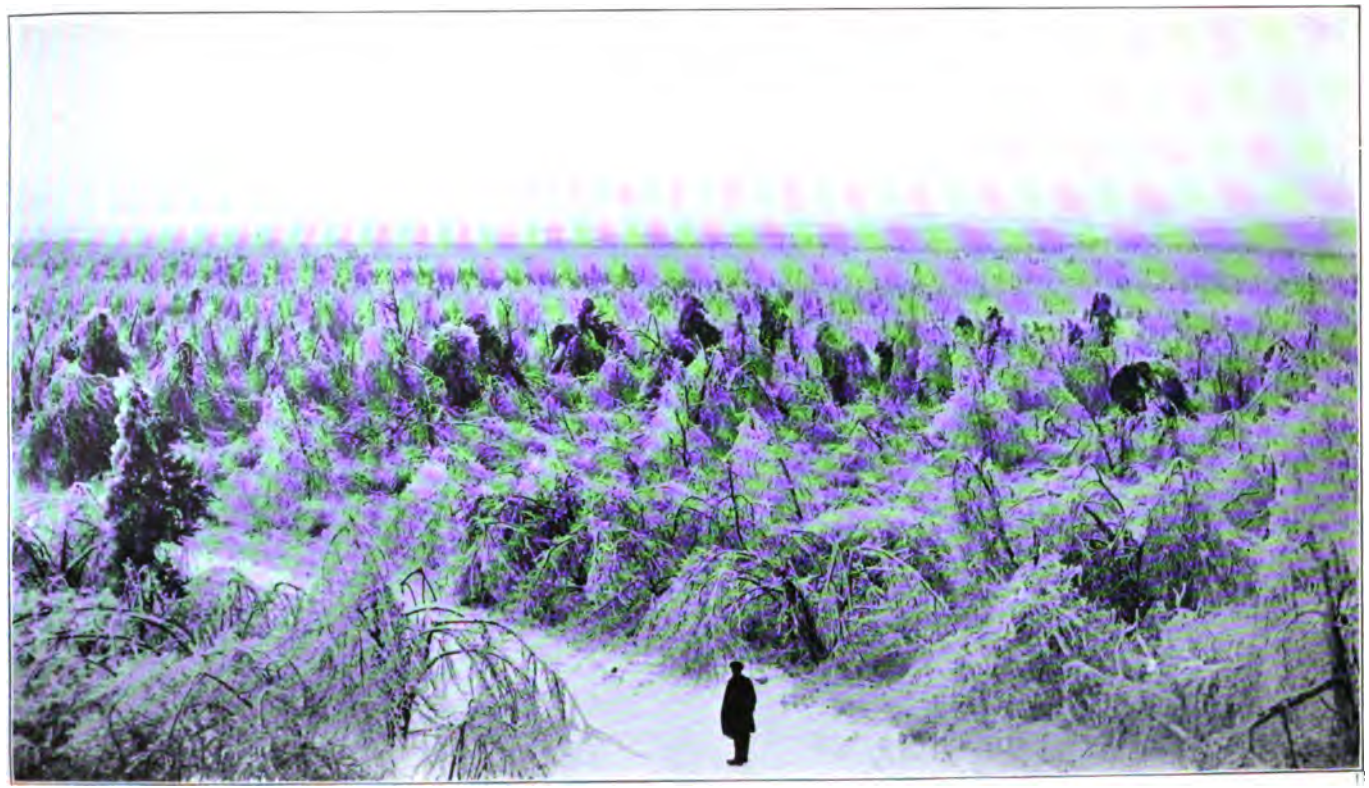
TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3-13, . . .	Daniel O'Brien, . .	Rowley, . .	Chas. Curtis, . .	3
177-5, Athol, .	Myron E. Stockwell, .	Royalston, . .	E. S. Stewart, . .	6
12-3, . . .	Wm. C. Chadwick, .	Russell, . .	- -	-
13-4, . . .	H. Edward Wheeler, .	Rutland, . .	H. E. Wheeler, . .	6
- -	- -	Salem, . . .	Oliver G. Pratt, .	1
1046-M, . .	Chas. J. Penniman, .	Salisbury, . .	Chas. J. Penniman, .	3
202-3, . . .	C. D. Strickland, .	Sandisfield, .	- -	-
76-2, . . .	Jerome R. Holway, .	Sandwich, . .	Lincoln Crowell, .	5
- -	T. E. Berrett, . .	Saugus, . .	T. E. Berrett, . .	1
4-16, . . .	C. E. Tilton, . .	Savoy, . . .	- -	-
141-4, . . .	Chas. M. Litchfield, .	Scituate, . .	Wm. F. Ford, . .	5
462-J-2, Pawtucket.	Herbert S. Baker, .	Seekonk, . .	C. A. Smith, . .	4
226, . . .	W. C. Morse, . .	Sharon, . .	Fred A. White, . .	4
34, . . .	R. W. Smith, . .	Sheffield, . .	- -	-
130-2, . . .	Chas. S. Dole, . .	Shelburne, . .	Chas. S. Dole, . .	6
- -	John C. Jackson, .	Sherborn, . .	Geo. W. Rock, . .	2
- -	Asa A. Adams, . .	Shirley, . .	Asa A. Adams, . .	2
- -	Edward A. Logan, .	Shrewsbury, .	Robt. C. Clapp, .	6
- -	Clarence N. Mellen, .	Shutesbury, .	E. C. Johnson, . .	6
- -	F. B. Butterworth, .	Somerset, . .	C. Riley, . . .	4
- -	- -	Somerville, . .	A. B. Prichard, .	2
- -	Louis H. Lamb, . .	South Hadley, .	Louis H. Lamb, .	6
151-14, . .	W. J. Lyman, . .	Southampton, .	- -	-
13-M, Marlborough.	Harry Burnett, . .	Southborough, .	Harry Burnett, .	6
11, . . .	Aimee Langevin, .	Southbridge, .	Aimee Langevin, .	6
- -	Benjamin M. Hastings,	Southwick, .	- -	-
134-4 and 53-2, .	Earl J. Potter, . .	Spencer, . .	G. Ramer, . .	6
167-2, Indian Orchard.	Frank C. Smith, .	Springfield, .	L. Fletcher Prouty, .	6
5-12, . . .	J. T. Wilder, . .	Sterling, . .	J. H. Kilburn, . .	2
87-M, . . .	George Schneyer, .	Stockbridge, .	George Schneyer, .	6
176-W and 127, .	Albert J. Smith, .	Stoneham, . .	G. M. Jefts, . .	3
121-3 and 218-2, .	Frederick H. Pye, .	Stoughton, . .	W. P. Kennedy, .	4
166-2, Hudson, .	Harold A. Priest, .	Stow, . . .	H. W. Herrick, . .	2
6-1, Fiskdale, .	Charles M. Clarke, .	Sturbridge, .	C. M. Clarke, . .	6
- -	Seneca W. Hall, . .	Sudbury, . .	Chas. A. Brackett, .	2
46, South Deerfield.	A. C. Warner, . .	Sunderland, .	Richard Graves, . .	6
58-4, Millbury, .	R. H. Richardson, .	Sutton, . .	R. H. Richardson, .	6

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
1911-J, Lynn,	Everett P. Mudge,	Swampscott,	Everett P. Mudge,	1
62-Y, Warren,	Amos F. Maker,	Swansea,	A. E. Arnold,	4
1 and 320,	Fred A. Leonard,	Taunton,	H. M. Briggs,	4
39 and 30,	C. A. Fletcher,	Templeton,	J. B. Wheeler,	6
4249-J,	Harris M. Briggs,	Tewksbury,	H. M. Briggs,	3
102-3 and 161-4,	Elmer C. Chadwick,	Tisbury,	H. W. McLellan,	5
269-16, Winsted, Conn.	Rupert E. Clark,	Tolland,	- -	-
36-6,	W. E. Burnham,	Topsfield,	Wayland E. Burnham,	1
14-4,	Mark R. Colby,	Townsend,	Wm. W. Copeland,	2
- -	Walter F. Rich,	Truro,	J. H. Atwood,	5
25-12,	C. J. Allgrove,	Tyngsborough,	C. J. Allgrove,	3
278-3,	George R. Warren,	Tyringham,	- -	-
9-3,	Henry E. Allard,	Upton,	Clarence L. Goodrich,	6
- -	Louis F. Maroney,	Uxbridge,	Frank J. O'Brien,	6
58,	W. E. Cade,	Wakefield,	W. W. Wittredge,	3
9-11 and 9-23, Brimfield.	Leon H. Thompson,	Wales,	M. C. Royce,	6
149-2,	Adam E. Bock,	Walpole,	Philip R. Allen,	2
6,	George L. Johnson,	Waltham,	W. M. Ryan,	2
279,	A. H. Pigeon,	Ware,	F. Zeissig,	6
187,	James J. Walsh,	Wareham,	J. J. Walsh,	5
- -	T. M. Collins,	Warren,	Nathan H. Powers,	6
73-12,	C. A. Williams,	Warwick,	Chas. Bass,	6
11, Becket,	A. L. Hayes,	Washington,	- -	-
116, Newton North.	Van D. Horton,	Watertown,	Van D. Horton,	2
31-3,	Howard C. Haynes,	Wayland,	D. J. Graham,	2
101-R,	E. L. Wallis,	Webster,	C. Klebart,	6
9 and 724,	John P. Doyle,	Wellesley,	Thos. T. Watt,	4
- -	John Holbrook,	Wellfleet,	Wm. H. Gill,	5
- -	Henry Champlin,	Wendell,	G. E. Mills,	6
74,	Jacob D. Barnes,	Wenham,	Jacob D. Barnes,	1
36,	H. E. Lowe,	West Boylston,	H. E. Lowe,	6
- -	W. P. Laughton,	West Bridgewater,	O. Belmore,	5
114-3,	John H. Webb,	West Brookfield,	John H. Webb,	6
33,	Edward Johnston,	West Newbury,	Frank D. Bailey,	3
- -	- -	West Springfield,	George W. Hayden,	6
- -	B. P. Bissell,	West Stockbridge,	- -	-
57-15,	John Pease,	West Tisbury,	Jerry B. Mayhew,	5

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

TELEPHONE NUMBER.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
153-12,	Thos. W. Humphrey,	Westborough,	George E. Hayden,	6
- -	Thomas H. Mahoney,	Westfield,	- -	-
44-11,	Harry L. Nesmith,	Westford,	H. L. Nesmith,	3
148-22 and 148-23,	Myron M. Clapp,	Westhampton,	- -	-
1-3,	W. F. Neal,	Westminster,	G. A. Sargent,	6
37 and 1392-M, Waltham.	B. R. Parker,	Weston,	E. P. Ripley,	2
1268-M,	Christopher Borden,	Westport,	Christopher Borden,	4
- -	Elmer E. Smith,	Westwood,	Martin Sorenson,	4
185-M,	Walter W. Pratt,	Weymouth,	C. L. Merritt,	4
- -	- -	Whately,	Rylan C. Howes,	6
349-W,	C. H. Randall,	Whitman,	C. A. Randall,	5
1-4,	Henry I. Edson,	Wilbraham,	Henry I. Edson,	6
- -	John Brown,	Williamsburg,	- -	-
329-W,	Wm. H. Davies,	Williamstown,	Wm. H. Davies,	6
19-4,	Edwin L. Day,	Wilmington,	Oliver McGrane,	3
102-4,	T. C. Flint,	Winchendon,	Waldo F. Streeter,	6
- -	David DeCourcy,	Winchester,	S. S. Symmes,	3
201-12,	Amos S. Ferry,	Windsor,	- -	-
- -	- -	Winthrop,	Harry Hills,	1
- -	Frank Tracy,	Woburn,	Wm. Butler Jones,	3
3923-M, Cedar,	W. N. Avery,	Worcester,	Thos. E. Holland,	6
10-22,	Chas. A. Kilbourn,	Worthington,	- -	-
69 and 21-5,	Geo. H. E. Mayshaw,	Wrentham,	Ernest B. Mayshaw,	4
2-2, Barnstable,	Henry R. Usher,	Yarmouth,	Frank B. Homer,	5



On Jacob's Ladder after the ice storm of November 28.

Public Document No. 73

The Commonwealth of Massachusetts

ANNUAL REPORT

OF THE

COMMISSIONER OF CONSERVATION

AND

STATE FORESTER

FOR THE

YEAR ENDING NOVEMBER 30, 1921

DEPARTMENT OF CONSERVATION

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

The Commonwealth of Massachusetts

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts.

I respectfully present herewith for your consideration my second annual report as Commissioner of Conservation for the fiscal year ending Nov. 30, 1921.

WILLIAM A. L. BAZELEY.

CONTENTS.

Part I.

Report of the Commissioner of Conservation.

	PAGE
Forestry	12
Fish and Game	12
Animal Industry	13
Forest Fires	14
State Forests	14
Standish Monument Reservation	17
Conventions	17
Lectures	18
Foresters' Meetings	18
Financial Statements:	
Purchase and Development of State Forests	19
Maintenance of Nurseries	19
Purchase of Mount Grace	20
Maintenance of Standish Monument Reservation	20
Recommendations for Legislation:	
Division of Forestry	21
Division of Fisheries and Game	21

Part II.

Report of the Division of Forestry.

New Legislation	29
Organization	30
State Plantations	31
Examinations	33
Nursery Work	33
Forest Surveys	35
Ice Storm	35
White Pine Blister Rust	36
State Forests	36
Report of State Fire Warden	40
Report of Superintendent of Gypsy Moth Work	50
General Conditions	50
Summary of Conditions by Divisions	50
Federal Work in Massachusetts	53
Special North Shore Work	54
Financial Statement	55

Appendix.

Financial Statement	59
Summary of Town Expenditures and Reimbursements	61
Distribution of Supplies	71
Expenditures and Receipts on State Forests	72
List of Forest Wardens and Local Moth Superintendents	73

OUTLINE OF REPORT.

This report is divided for convenience and economy into four parts: —

Part I. The organization and general work of the Department of Conservation.
Part II. The work of the Division of Forestry.
Part III. The work of the Division of Fisheries and Game.
Part IV. The work of the Division of Animal Industry.

Parts I and II are printed in one volume, as Public Document No. 73.

Part III is printed in a separate volume as Public Document No. 25.

Part IV is printed in a separate volume as Public Document No. 98.

PART I

REPORT OF THE COMMISSIONER OF CONSERVATION

The Commonwealth of Massachusetts

ANNUAL REPORT OF THE COMMISSIONER OF CONSERVATION.

As the law prescribes the form of our annual report there can be but little variation in its style from year to year. The reports of accomplishment in each branch of the service were prepared by direction of the Commissioner by those in immediate charge of the various activities, and, while not treated with exhaustive detail, cover the more important facts and conclusions.

The proper conservation of our natural resources in Massachusetts is a subject for deep thought and the exercise of our best judgment. Upon the success of such a policy depends the preservation as a heritage for future generations of the forests, wild life, and water resources, all of which, if judiciously and sensibly managed, will add much to the material prosperity of the entire State.

The work of the three divisions of this Department has been vigorously prosecuted during the past year, yielding results which I firmly believe to be of immense value to the Commonwealth. I realize that this splendid progress could not have been accomplished without aid, and I desire to avail myself of this opportunity to express in heartiest fashion my acknowledgment of the generous support accorded me by the General Court, as well as the public in general. I desire especially to express my grateful appreciation of the work of the State House news service, which has from time to time given to the people of the Commonwealth, through the medium of the newspapers, information concerning important subjects with which this Department is dealing.

Pursuant to the requirements of the act creating the Department of Conservation, the Commissioner, with the directors of

divisions acting as advisers, has determined all policies of a departmental nature. This has required the holding of twenty-one meetings during the year.

Conservation of Our Forests.

The late President Roosevelt, in an address made in 1903, said, "The forest problem is in many ways the most vital internal problem before the American people to-day;" and again, "The more closely this statement is examined the more evident its truth becomes." Eighteen years have elapsed since the above utterance, and the importance of the problem has increased with each succeeding year. In Massachusetts forestry is a matter of immediate interest to every household, and I am happy to express the conviction that the splendid progress made in its promotion in our State is significant of a healthy growth of sentiment which has been created in large measure by the educational work of this Department. While we have been engaged in the enterprise of reforestation only a comparatively brief time, we may point with pride and satisfaction to the gratifying dimensions already attained by the plantations which have been established throughout the State, and it requires only a continuation of the general interest which has been aroused along these lines to reclaim, beautify, and bring to a producing stage many thousands of acres now unsightly and unproductive.

Conservation of Wild Life.

The interdependence of forestry and fisheries and game has been forcibly illustrated during the past year by the successful operation of the fishway around the 30-foot dam which formed the first barrier to anadromous fish coming up the Merrimack river. This fishway was used by certain salt and fresh water species. By the installation of a fishway around the only remaining structure, the Merrimack was opened from the New Hampshire line to the sea. History has repeated itself, and the Merrimack is once more a great fisheries highway as far as this State is concerned. From its shores have long since disappeared the magnificent forests, but the hinterland still contains sufficient growths to insure a steady flow of water, though the spring and fall freshets are at times of terrific proportions.

The increase in wild life must go hand in hand with the increase of the forests. The rapidly increasing number of fishermen and sportsmen demand redoubled efforts to increase the stock available for distribution. The fish will need a greater number of cold water brooks, the birds and game larger areas of properly forested land.

The work of the Division of Fisheries and Game was greatly restricted owing to the lack of appropriations, especially as relates to the propagation of fish and game. Some of the usual activities — as, for example, the collection of white perch, wall-eyed pike eggs, and some lobster work — had to be discontinued. However, the total volume of work compared very favorably with that of past years.

To specify the work more in detail: —

Revenue turned into the general treasury (mostly fees for hunting and fishing licenses) was $113,263.11.

Educational work was carried on as usual, including distribution of laws, exhibitions at fairs, and upwards of seventy-five lectures with lantern slides and moving pictures.

Three fish hatcheries, two rearing stations, three bird farms and two State-owned reservations were operated, with a production of approximately 1,923,471 fish and 6,144 birds.

Work was continued in further organizing the newly created department of fish inspection.

The law enforcement department handled more particularly difficult cases than usual, and disposed of 523 cases, being a large increase over previous records.

Conservation of Domestic Animals.

The function of the Division of Animal Industry is the conservation of animal life by prevention, control, and eradication of contagious diseases to which domestic animals are susceptible.

It is estimated that considerably more than one-third of the food consumed by the people of this country has for its source the domestic animal. In order that this source shall be operative in the highest degree possible, it is necessary that the different species propagate in large numbers and rapidly develop to the point at which their products or their carcasses

become available as human food. Such propagation and development depend very largely upon the prevention of contagious disease among them, or its control and eradication when it has appeared.

Domestic animals if maintained free from disease are not only valuable as producers of food by their products and carcasses, but are also recognized as vitally necessary to successful agriculture. Their by-products are the prime factors in many kinds of commercial trade. Horses are not only a means of recreation and pleasure to the people, but are indispensable and invaluable in the manufacture of many varieties of biological products used in the preservation of human life.

We refer to the accompanying report of the Director of Animal Industry for a detailed description of the conservation activities of this Division.

Forest Fires.

As we have stated in previous reports, the greatest menace to our forests to-day is from fire. The waste in that particular depends entirely upon the precautions taken to avoid fires, and prompt action in putting them out when once started. To guard against this evil we are maintaining a fire-prevention system acknowledged to be the equal of any in the country. It is stated by those in a position to know that a very large proportion of the forest fires which occur in this Commonwealth is due to the carelessness of those who frequent the woods. To minimize this so far as possible we are constantly giving the subject widespread publicity in our efforts to arouse the public to a full realization of their duty. The complete record of the work accomplished along the line of fire prevention will be found in the report of the State Forester.

State Forests.

Pursuant to and in accordance with the provisions of the acts of the Legislature of 1920 and 1921, passed for the purpose of establishing and enlarging the State forests of the Commonwealth, there have been acquired during the fiscal year just ended a total area of 14,188 acres of land. The acquisition of this land in various sections of the State constitutes in part

the creation of four new State forests, and also the addition of certain areas of land to State forests already established. The distribution of the land purchased during the year is as follows: —

UNDER CHAPTER 132, GENERAL LAWS.

Additions to already existing forests:	Acres.
Savoy Mountain State Forest	1,201
Erving State Forest	651
Conway State Forest	66
Tolland State Forest	320
Colrain State Forest	294.8
New State forests:	
Wendell State Forest	2,124.2
Sandwich State Forest	507.3
Bear Mountain State Forest	5,174.0

UNDER CHAPTER 344, ACTS OF 1921.

New State forest:	Acres.
Mohawk Trail State Forest	3,256

UNDER CHAPTER 606, ACTS OF 1920.

Additional land:	Acres.
Mount Grace State Forest	595.2

The major portion of the above land acquired under Chapter 132, General Laws, has been secured at a price of $4.50 per acre or under. Of the new State forests established under this act during the past year the one in Wendell comprises a portion of a larger tract of land situated in the townships of Wendell and Montague that is suitable in the main for no other purpose than that of producing forest trees. A large percentage of it is at present covered with a young growth of mixed hardwoods, and the remaining portions are sufficiently open for stocking with young trees of coniferous species. The tract is readily accessible at present, and can be made more so by clearing out certain abandoned roads which run through it.

The Sandwich State Forest, situated partly in Sandwich and partly in Bourne, comprises a portion of a considerable tract of country in both townships which a long period of years has indicated will never be of value for any purpose other than tree production. It is situated in the vicinity of the Cape Cod

Canal, is readily accessible, and touches at one point on the main State highway leading down the Cape. The soil of the major portion of the tract is of a light, sandy nature, but it is of sufficient quality for the production of certain coniferous species. Scotch pines planted on a portion of the area a few years ago have made an excellent growth, and it is certain that, given the necessary protection from fire, this block of country can be made to produce in the necessary length of time a stand of forest trees that will be a real asset to the Commonwealth. The land thus far secured has cost $2 per acre, and additional land to the extent of 1,500 acres is contemplated for purchase.

The Bear Mountain State Forest, situated in Great Barrington and Monterey, in southern Berkshire County, constitutes a rather rugged tract of land which, like much of the southern Berkshire region, is and always has been given over to the production of tree growth for wood-using purposes. It adjoins the Arthur Warton Swann State Forest, and comprises a portion of the former Pearson estate.

Under the provisions of chapter 344, Acts of 1921, the purchase of land constituting the new Mohawk Trail State Forest was begun during August last, and up to the end of the fiscal year just ended land to the extent of 3,256 acres has been purchased, situated in the towns of Charlemont, Hawley, Florida, and Savoy. The land acquired lies on both sides of the trail, and extends for a distance of about five miles on either side of it between the junction of the Cold and Deerfield rivers and the village of Drury. It is a pleasure to report the acquisition of this new Mohawk Trail State Forest, for it means the assured preservation for all time of one of the most beautiful scenic sections of the now famous highway. A few small additional parcels of land will be added to that already acquired during 1921, in order to properly complete the exterior boundaries of the Mohawk Trail State Forest.

Under chapter 606, Acts of 1920, additional land has been acquired for the Mount Grace State Forest, bringing the present total area up to about 1,000 acres, which takes in the whole southern portion of the mountain, and extends for a short distance across the roads around it both on the east and west sides.

The work of surveying acquired lands during the past year has progressed favorably, and at the present time about 95 per cent of the boundary surveys have been completed. In addition, type data have been secured on portions of the lands acquired. Plans of the new forests are now being assembled, and should be ready by spring.

Standish Monument Reservation.

The renovations on the monument and reservation which were started during the fall of 1920 were continued this spring. The inside iron stairway was thoroughly overhauled and painted, new parts being substituted where necessary. A new cement walk was made around the monument and a cinder walk was made at the approach leading up to the monument. There were 1,700 common barberry (*Berberis vulgaris*) bushes planted on both sides of the approach. The road leading from the main highway through the reservation and to the monument was put in good condition, and the woodland on the hill was thinned over about 5 acres. A survey of the outside boundary lines was made and cement corner posts installed.

An attendant in the employ of the State was stationed at the tower from May 26 to October 15, and during that period a record was kept of the visitors to the monument. The total number of visitors to the monument by automobile during this period was 34,370, the number of cars being 6,773. It was estimated that between 5,000 and 6,000 others visited the momument, making a total of approximately 40,000 visitors during the year. It is possible that this number is somewhat larger than the usual number each season, as the Plymouth Tercentenary celebration doubtless drew many visitors to Duxbury.

Conventions.

The Commissioner has attended several meetings outside the State where questions of importance relating to forestry and fish and game protection were discussed.

Association of State Foresters, Harrisburg, Pa., December 7 to 10.
Society of American Foresters, New York City, N. Y., December 20.
American Fish and Game Protective Association, New York City, N. Y., January 15.

Association of State Foresters, Chestertown, N. Y., September 21.
Society for Protection of New Hampshire Forests, North Woodstock, N. H., August 31.
American Plant Pest Committee, Albany, N. Y., November 8.

In addition there were several meetings in or near Boston, the most important of which was the meeting of the New England Section, Society of American Foresters, held at Myles Standish State Forest, July 28 to 30. This meeting is described in detail elsewhere in the report.

Lectures.

The Department has had an unusual number of applications for lectures. We have assembled a fair collection of colored slides with which to illustrate the talks, and have also a small portable lantern screen, so that we are equipped with a complete outfit for displaying them. Our lectures, which during the past year numbered nearly fifty, reach a large variety of people, including Boy Scouts, women's clubs, fish and game associations, schools, boards of trade, etc. So numerous have the calls for lectures become that they take much of the spare time of three of the forestry officials, the Commissioner, the secretary and the chief forester.

It is also fitting to state here that a great deal of this work of lecturing is entirely voluntary on the part of our employees, as the talks are often given in the evening or at times outside the regular hours of work, and no extra pay is received for them. It is possible that if the demand continues a suitable fee will have to be charged or sufficient funds provided for an extra employee to take care of the work.

Foresters' Meeting.

At the invitation of the Commissioner the members of the New England Section, Society of American Foresters, met at the Myles Standish State Forest in Plymouth, July 28 to 30. Camping equipment and meals were supplied by the Commonwealth. The meeting was well attended, almost the entire membership of sixty being present. The foresters were shown not only the details of management on one of our largest forests

New England Section, Society of American Foresters, at Myles Standish Forest, July 28 to 30, 1921.

but also inspected our forest fire observation towers and fire apparatus in adjoining towns. The visitors seemed to go away with a high opinion of the work being done for forestry in Massachusetts.

Financial Statement.

Purchase and Development of State Forests.

Receipts.

Balance brought from 1920	$22,475 67
Appropriation for 1921	175,000 00
	$197,475 67

Expenditures.

Services	$20,258 37	
Travel	5,929 96	
Maps, photographs, etc.	585 63	
Land	96,347 74	
Equipment	1,563 53	
Supplies	2,332 57	
Contract planting and brushing	3,792 63	
Express and teaming	601 40	
Sundries	343 56	
		131,755 39
Balance on hand Nov. 30, 1921		$65,720 28

Maintenance of Nurseries.

Receipts.

Appropriation for 1921	$25,000 00

Expenditures.

Services	$15,627 28	
Travel	194 81	
Equipment	506 40	
Supplies	1,030 47	
Express and teaming	558 08	
Seeds and seedlings	750 69	
Rent of land	144 70	
Sundries	28 95	
		18,841 38
Balance on hand Nov. 30, 1921		$6,158 62

PURCHASE OF MOUNT GRACE.

Receipts.

Balance brought from 1920	$29,750 00
Appropriation for maintenance	1,000 00
	$30,750 00

Expenditures.

Services	$2,373 88	
Travel	710 73	
Land	22,400 00	
Equipment	14 56	
Supplies	402 38	
Teaming, etc.	123 60	
Sundries	5 65	
		26,030 80
Balance on hand Nov. 30, 1921		$4,719 20

MAINTENANCE OF STANDISH MONUMENT RESERVATION.

Receipts.

Appropriation for 1921	$3,000 00

Expenditures.

Services	$1,652 39	
Travel	103 85	
Equipment	54 28	
Supplies	1,043 82	
Express, teaming, etc.	58 06	
Sundries	81 02	
		2,993 42
Balance returned to treasury Nov. 30, 1921		$6 58

RECOMMENDATIONS FOR LEGISLATION.

The following recommendations of the Commissioner for legislative action have been forwarded to the Secretary of the Commonwealth, together with the drafts of the bills to cover the action, in accordance with the provisions of chapter 30, section 33, General Laws: —

Portable sawmill at work. There are three hundred of these mills, and they do 75 per cent of the logging in Massachusetts. We advocate that they be obliged to give notice to this Department of their intention to operate on each site. This one has an approved spark arrester.

Division of Forestry.

Relative to Portable Sawmills. — We believe that the forest fire prevention system may be further strengthened by giving more attention to the portable sawmill.

Statistics show that nearly 300 of these mills are in operation in Massachusetts each year, and that they are moved frequently from one location to another. For this reason we have not been able to get accurate knowledge of their location without involving considerable expense. We therefore recommend that all persons intending to operate portable sawmills shall first file their intention so to do with the Department of Conservation, stating the proposed location and the probable duration of the operation. We also urge the importance of having all slash and brush destroyed for a distance of at least 150 feet from the mill. The Commissioner therefore recommends the passage of an act to accomplish this purpose.

Division of Fisheries and Game.

1. *To allow the Governor to proclaim Temporary Close Seasons on Fish and Game.* — Occasionally it happens that because of climatic conditions, or because of a disease which may suddenly attack various species of fish and game, the continuance of an open season as prescribed by law might seriously deplete, if not exterminate, the species affected, and as this might occur at a time when the Legislature is not in session, it is expedient that the Governor be clothed with authority to set aside the open season.

2. *To allow Wardens and Deputy Wardens of this Division to enter upon and cross Private Property.* — Under the new Revised Laws only the Director has the right to cross private property in the performance of his duties. If the wardens and deputies do not have this authority their effectiveness is very much reduced. When this Department was under the control of "commissioners," and the men were "deputy commissioners," the law could be interpreted to give them this right.

3. *To have the Fish and Game Law Amendments take Effect on January First of the Year following the Date of their Enact-*

ment. — It is desirable to get information of changes in the laws broadcast before attempting to enforce new laws, and as the news seems to travel slowly it would seem expedient to have the new laws go into effect on a certain date and thus give the public ample time to acquaint themselves with them.

4. *To have the Fishing License Law apply to All Inland Waters and to amend the Laws relative to the Issuance of Duplicate Certificates and the Exportation of Game.* — The present law requires a license for fishing only in those inland waters which have been stocked by this Department since Jan. 1, 1910. The publication yearly of lists of waters stocked during the year involves considerable expense. Further, by reason of the fact that many streams are known by various names, much confusion is created in the minds of persons who wish to determine whether a stream has or has not been stocked. Many of the unstocked waters are being depleted, and we believe they should be protected by requiring licenses for fishing therein.

A person wishing to secure a duplicate of a lost or destroyed license is required by the present law to apply, either in person or by letter, at the office of the Division of Fisheries and Game. This is an inconvenience to the public and creates a volume of work in the office of the Division at the busiest season of the year. An amendment permitting the issuance of duplicates by city and town clerks will remedy this, and the 25-cent fee will have the effect of reducing the number of licenses lost.

Under the existing law there is no limit to the amount of fish or game which a non-resident may take out of the State under his license, except in the case of birds and brook trout. Inasmuch as the Department is bending every effort to conserve the supply of wild life within the Commonwealth, it seems only just and fair that a limit be set.

5. *To permit the Issuance of Licenses to Certain Minors under Restrictions.* — There are many minors under fifteen, the age now established by law, who could be allowed to have permission to hunt with firearms if accompanied by some one who could coach them along and prevent them from trying reckless stunts. The license would not be operative if they went out alone.

6. *To allow Non-Resident Hunters the Right to attend Field Trials the Same as the Right now possessed for Fox-hunting Activities.* — This is to take care of an oversight in the hunting license law and allow field trials which will not injure our game and thus not put a heavy burden on non-residents who are here for a few days only.

7. *To permit the Importation into Massachusetts of Fish and Game taken legally outside the Commonwealth and to permit Possession of Such Fish and Game after the Close of the Season.* — The present laws permit the taking of a bag limit of fish and game on the last day of the open seasons, but the person taking it cannot reasonably be expected to dispose of the same immediately. The accompanying act will give a reasonable length of time for the disposal of game and fish legally taken during the open season. It will also permit the importation and possession, after the close seasons in Massachusetts, of fish and game taken legally outside of the Commonwealth.

8. *To make the Laws of Massachusetts relative to Migratory Birds conform with the Laws of the United States.* — The Federal government has entered into a treaty with Great Britain for the uniform protection of migratory birds on the American continent. The Federal laws in this connection render conflicting State laws void. For the convenience of the public, and for the proper enforcement of the law it is desirable to have the laws of this Commonwealth conform with the Federal rules and regulations.

9. *To provide for Reports from Trappers to show to what Extent they are commercializing the Fur-bearing Animals.* — At the present time we have no way of estimating the number of fur-bearing animals in this Commonwealth. They are a valuable natural resource, and we should have information as to their abundance and value.

10. *To permit the Importation of Live Hares and Rabbits.* — Our season is shorter than in other States, and many interested parties desire to purchase live hares and rabbits to stock our woods. Under the present law they must be imported and liberated during the open season, and they may be killed off immediately with no chance to propagate. It is surely no

harm to bring them in during the close season to stock our covers if they have been legally taken in some other State.

11. *To prohibit the Use of Dogs during the Open Week on Deer.* — Many dogs are taken into the woods during the deer week under the guise of hunting fox, raccoons, rabbits, etc. They are really used to help take the deer, but it is impossible to meet the situation under the present law. If all dogs are ruled out of the woods during the open week, the same as rifles are, the matter can be handled more fairly.

12. *To prohibit the Use of Snares.* — The present law forbids the use of wire snares, but cord snares are just as deadly to dogs and game and also human beings. No snares of any sort should be allowed in the woods.

13. *To extend the Close Season on Quail in Certain Counties.* — There are few quail left in these counties. While they have been protected during the past few years, and have shown an increase, it has not been sufficient to warrant an open season.

14. *To repeal the Salmon Law on Lake Quinsigamond.* — Under present laws the Commissioner of Conservation has the right to make rules and regulations for the taking of salmon, and there is no reason why they should not apply to this lake as well as all others. The situation which required a special law for that lake no longer exists.

15. *To regulate the Catching and Sale of Fresh-Water Fish.* — Winter fishing and the absence of restriction on the sale of pond fish have been two of the principal causes of the depletion of inland fisheries during the past few years. Progressive conservation demands that catch and sale limits be established.

16. *To extend the Close Season on Black Bass.* — Bass are late spawners and need more time to carry eggs than other fish. They are easily caught in the late spring after hibernating and not eating during the winter.

17. *To establish the Authority of the State Inspector of Fish.* — The original act imposed certain restrictive measures on the sale of fish, but it contains no definite statement as to the authority of the inspector or his deputies to enforce the provisions of these sections.

18. *To amend Certain Sections of Chapter Ninety-four of the General Laws.* — It is advisable to change the wording in a few

places so that the provisions will be clearly understood and no inconsistent statements be contained therein.

19. *To allow the Commissioner of Conservation to sell Certain Lands and Buildings in the Towns of Palmer and Wilbraham.* — It seems advisable to either turn over to some other State department or to restore as taxable property certain parts of the Palmer fish hatchery and the Wilbraham game farm as appear to be no longer needed for maintaining operations at these two stations.

PART II

REPORT OF THE DIVISION OF FORESTRY

REPORT OF THE DIVISION OF FORESTRY.

The Division of Forestry continued throughout the year to give earnest attention to the important matters with the administration of which it is charged by the General Laws. The more important of these activities include giving aid and advice to landowners of the Commonwealth with respect to the proper management of their forest lands, for which service they are required to pay only the traveling expenses of the expert making the examination; the development and care of demonstration forest plantations under the so-called reforestation act; the production and distribution of young forest trees from the nurseries established and maintained by this Division; the suppression of the gypsy and brown-tail moths; the operation of a forest fire prevention system; and the planting and management of the lands acquired for State forests.

All of the above activities are described in detail on other pages of this report.

New Legislation.

In pursuance of the recommendations of last year's report the following new legislation was enacted by the General Court of 1921.

The forest warden appointment law was amended so that the State Forester may appoint the forest warden upon the failure of the mayor or selectmen so to do after proper notice.

The law allowing the State to reimburse towns for purchase of fire fighting equipment was also amended so that the towns which may be reimbursed for this purchase may also be reimbursed for expense of replacing this equipment.

The so-called reforestation act (section 10, chapter 132, General Laws) was also amended, giving the owner when land is reconveyed the privilege of cutting trees less than eight inches in diameter if the State Forester so determines.

The act relative to reimbursement of towns for loss of taxes on land used for State forests was also amended.

An act authorizing the Governor to proclaim a close season for game in time of drought was also passed.

Legislation exempting foresters, assistant foresters, engineers, surveyors, forest fire observers and foremen employed temporarily in the purchase and development of the State forests was enacted in the form of an amendment to section 33 of chapter 132 of the General Laws.

Organization.

During the year 1921 the personnel of the Division has remained practically unchanged. Several temporary surveyors and draftsmen have been employed on the State forests; as far as possible local surveyors have been employed, as these men are more familiar with the ground and can therefore do more economical work.

The present organization, Nov. 30, 1921, is as follows: —

William A. L. Bazeley . . . Commissioner and State Forester.

Forestry Division.

General Staff.

Charles O. Bailey	Secretary.
Elizabeth Hubbard	Senior clerk.
Elizabeth T. Harraghy	Stenographer.
Jennie D. Kenyon	Stenographer.
Mabel R. Hamnett	Clerk.
Dorothy J. Sanford	Assistant clerk.

General Forestry.

Harold O. Cook	Chief forester.
Frank L. Haynes	Assistant forester.
James Morris	Assistant forester.
Robert B. Parmenter	Assistant forester.
John A. Palmer	Superintendent, Amherst Nursery.
Fred W. Parker	Superintendent, Bridgewater Nursery.
Eben Smith	Superintendent, Barnstable Nursery.

Moth Work.

George A. Smith	Superintendent.
Francis V. Learoyd	Business agent.

District Moth Men.

1. Michael H. Donovan, Beverly.
2. William A. Hatch, Marlborough.
3. John J. Fitzgerald, Haverhill.
4. Clarence W. Parkhurst, Foxborough.
5. Walter F. Holmes, Bussard's Bay.
6. Harry B. Ramsey, Worcester.

FOREST FIRE PREVENTION.

MAXWELL C. HUTCHINS . . . State Fire Warden.
JOSEPHA L. GALLAGHER . . . Clerk.

District Fire Wardens.

1. JAMES E. MOLOY, Woburn.
2. JOHN H. MONTLE, Fall River.
3. JOSEPH J. SHEPHERD, Pembroke.
4. JOHN P. CROWE, Westborough.
5. ALBERT R. ORDWAY, Westfield.
6. JOSEPH L. PEABODY, Winchendon.

Observers and Location of Fire Towers.

Mrs. JOHN CONDON, Harwich.
JOSEPH W. JENKINS, Barnstable.
Mrs. W. I. MOODY, Falmouth.
W. F. RAYMOND, Bourne.
F. L. BUCKINGHAM, Kingston.
Mrs. ALLEN Keniston, Martha's Vineyard.
S. EDWARD MATTHEWS, Middleborough.
GEORGE F. MOFFETT, Fall River.
EVERETT SHORT, Rehoboth.
CHARLES F. KIMBALL, Hanson.
EDWARD D. SPRAGUE, Hingham.
F. J. KUSTENMACHER, Sharon.
FRED R. STONE, Sudbury.
WILLIAM H. TYZZER, Jr., Wakefield.
C. E. BLOOD, Chelmsford.
LEON S. GIFFORD, Georgetown.
CAPLIS McCORMACK, Manchester.
JOHN F. MULCAHY, Mendon.
WILLIAM E. HOWARTH, Westborough.
JAMES W. MALEY, Wachusett Mountain.
MARK W. SHATTUCK, Watatic Mountain.
FRED A. LINCOLN, Warwick.
HARLAND BURROWS, Pelham.
MARY E. HALEY, Brimfield.
THOMAS MAGOVERN, Charlton.
N. C. WOODWARD, Shelburne Falls.
H. H. FITZROY, Savoy.
DAVID M. SMITH, Waltham.
FRANK WILSON, Chester.
JOHN E. CURTIN, Tolland.
FREDERICK K. SHEARS, Mount Everett.
ROBERT MILLER, Lenox.
HARRY GEORGE, Williamstown.
ALTON B. ELLIS, Acushnet.
ALVA SIKES, West Brookfield.
EUGENE SULLIVAN, Agawam.
WILLIAM H. ST. JOHN, Harvard.

STATE PLANTATIONS.

Reforestation.

About two-thirds of the plantations under our management were examined during the year, and the majority show satisfactory results. Our method of cutting around the individual tree to free it from brush is a decided improvement over former clean brushing methods, and more work has been done at a decidedly lower cost per acre, while the results are more satisfactory. Twenty-eight lots containing a total of 732 acres were brushed at an average cost of about $2.50 per acre. Seven new lots were planted and two other lots which had been partly burned over were restocked.

Planting.

[W. p.=white pine; r. p.=red pine; S. p.=Scotch pine; J. p.=Jack pine; sp.=spruce; hem.=hemlock.]

Lot.	Town.	Area (Acres).	Trees.
Greenwood	Gardner	80	2,000 w. p.
Perry	Medfield	15	10,000 w. p.
Robertson (2)	Barre	100	50,000 w. p. 10,000 r. p.
Baseley	Uxbridge	75	20,000 w. p. 15,000 r. p. 10,000 S. p. 5,000 J. p. 1,000 sp. 500 hem.
Fiske	Weston	40	12,700 w. p. 2,500 S. p. 2,225 J. p. 4,500 sp. 200 r. p.
Spencer	Oakham	70	50,000 w. p.
Taft	Uxbridge	4	5,000 w. p.

Brushing.

Lot.	Town.	Area (Acres).	Brushed (Acres).
Lawrence	Ashburnham	63	63
Rockwood (2)	Ashburnham	130	20
Smith (2)	Ashburnham	160	48
Brochu	Attleboro	25	25
Robertson (2)	Barre	100	55
Stone	Brookfield	37	30
Dewar	Carlisle	40	40
Greenwood	Gardner	80	40
French (2)	Lancaster	83	83
Civic League	Nantucket	133	86
Spencer (2)	Oakham	134	30
Hastings	Orange	11	11
Dean	Rutland	55	35
French	Rutland	26	26
Baker-Hurd (2)	Rutland-Barre	132	30
Schoonmaker	South Ashburnham	38	38
Putnam	Spencer	8	8
Rice (3)	Spencer	200	25
Lynde	Westminster	39	39
Total		–	732

Examinations.

The examinations of private woodlands total 60, which is a few less than last year.

It is interesting to note how business conditions affect the kind of examinations made. The year 1920 was a prosperous one in the lumbering business, so that a majority of our clients wished for an estimate of the value of their woodlands and advice on their sale and operation. The year 1921 was a poor one in the lumbering industry, and requests for advice along these lines were few.

Subject.	Number of Examinations.	Area (Acres).
Fire damage	1	60
Ice storm	1	–
Insects and diseases	18	205
Marketing	15	961
Planting	10	306
Taxation	2	138
Thinning	7	247
Thinning and planting	7	554
Totals	61	2,471

Nurseries.

During the spring of 1920 there were shipped from our nurseries approximately 2,290,000 trees. This total is a little lower than was expected, due in part to the severe weather conditions of the previous winter. However, more than 90 per cent of the inventoried number came through in good condition, so that the result may be considered very satisfactory.

One innovation may be noted. For some time past there has been an increased demand from cities and towns for planting stock. This year the Commissioner of Conservation, feeling that some of the stock might be given away and still enough would be left to fill the State reforestation program, obtained the consent of the Governor and Council to furnish cities and towns with trees free of cost. All municipalities within the Commonwealth owning their water systems were notified, and

more than 40 of them took advantage of the offer, receiving a total of 626,000 trees. The following table shows the distribution of all trees from our nurseries: —

	State Forests.	Reforestation.	Cities and Towns.	State Institutions.	Private Planting.	Total.
White pine	650,000	149,700	505,000	264,000	60,500	1,629,200
Scotch pine	168,000	12,500	87,000	65,000	7,000	279,500
Scotch pine (3-year)	48,000	–	–	–	–	48,000
Red pine	24,000	25,200	10,000	35,000	10,500	104,700
Jack pine	76,000	7,225	20,000	5,000	1,000	109,225
Spruce	82,000	5,500	4,000	7,000	14,250	112,750
Hemlock	–	500	–	–	–	500
Larch	–	–	–	–	6,550	6,550
Totals	988,000	200,625	626,000	376,000	99,800	2,290,425

Our nurseries are being built up to meet the increased demand of our own needs, and within two years we expect to have at least 20,000,000 trees of various age classes, allowing an annual output of about 4,000,000 four-year transplants. At the present time the nurseries contain about 10,000,000 trees, including all age classes.

Four acres of land have been added to the Amherst nursery and about five to the State Farm nursery, allowing room for an additional 2,125,000 transplants. Arrangements have been made at the Myles Standish Forest, the Swann Forest, the Otter River Forest and the Savoy Mountain Forest for the establishment of transplant nurseries to carry about 2,000,000 two-year trees. This stock will be allowed to stand for one or two years and then will be set out directly on the reservations, thereby effecting a considerable saving in expressage, because about 40,000 seedlings can be shipped from the main nurseries at about the same cost as 3,000 four-year transplants. All of these transplant nurseries will be large enough to permit of economically employing one or more men during the summer months.

Several hundred new seed frames have been built to take care of the proposed increase in the number of seedlings, and in addition to alterations in the Amherst nursery buildings we

have almost completed the installation of a new water system consisting of pump, tower-tank and pipe lines, and also the remodeling of housing facilities at the State Farm nursery.

Forest Survey.

The work of obtaining a complete survey of woodland conditions in the State was continued during the past summer and the forest survey of Hampshire County was completed. The report is nearly ready for publication. We have now detailed forest surveys of three counties, — Worcester, Plymouth and Hampshire. Norfolk County is partially completed and will be finished this summer.

It is impossible to plan an adequate forest policy for the State unless one knows not only the forest area of the State, as compared with the agriculture, but also the proportions of different types and age classes in the forest. It is this information that these county surveys are designed to supply.

Ice Storm.

The last days of our fiscal year were made noteworthy by the occurrence of the ice or glaze storm. Nothing of the kind has happened before in the lifetime of living men or living trees. The storm coated both shade and forest trees with hundreds of pounds of ice, and the weight snapped off huge branches and tops of trees, filling the streets and woodlands with débris, spoiling the symmetry and form of all trees, and injuring many beyond the possibility of repair. Naturally the first concern was felt for the shade trees, and this brought into our office an avalanche of appeals for advice and help. Although this Department legally and officially has nothing to do with the care of shade trees we did our best to meet the situation. Articles were issued to the press, a short, comprehensive bulletin published, lectures given before public meetings, and the local tree wardens were called together for conference and instructions. The principal message to the people was to the effect that the repair of the damage was something that would take years; that beyond the clearing of the débris haste was not necessary; and that all permanent repair work should be carefully planned.

In behalf of the tree wardens it should be said that they met the serious situation well. These officials work along from year to year on meager appropriations, and have no permanent force of men except in those towns where they are also gypsy-moth superintendents, and very little equipment. Suddenly they were called upon to handle a big job, and they were equal to the occasion. It is hoped that in the future their fellow citizens will have a higher appreciation of the importance of these officials and will be more liberal with the appropriations for shade-tree work.

White Pine Blister Rust.

The work of checking the spread of this disease is placed in the Plant Pest Division of the Department of Agriculture by the Legislature, so that our interest in it is more or less academic, although vital. Recent indications are that the disease is far more widespread than was at first supposed, and that it is absolutely essential that cultivated and wild *ribes* be eradicated from the near vicinity of white pines if they are to be saved.

In co-operation with the State Department of Agriculture *ribes* eradication was completed on the Otter River State Forest, and some preliminary scouting work done on other State forests to determine the presence of *ribes*. We plan to start on a thorough campaign of *ribes* eradication all over our State forests this summer, provided that sufficient funds are made available.

State Forests.

More than the usual amount of work has been done this year on the State forests owing to our being able to secure sufficient help at a rate of wage commensurate with the nature of the work. This work has been confined mostly to the cutting and burning of brush and opening up of old abandoned roads, which is necessary in most of these forests in order that they may receive better fire protection and be made accessible for fire fighting equipment, planting stock and crews. Several new tracts have been purchased and new State forests created located largely throughout the central and western portions of the State. The following is a report of the general work carried on in each forest: —

Myles Standish Forest.

The brush has been cut and burned on about 20 miles of highway, which includes the two roads leading from the superintendent's house to College Pond, and also Halfway Pond Road. About 12 miles of fire lines were brushed and plowed 25 feet wide along the southern and eastern boundary of the reservation. The Federal Pond Road, which lies west of College Pond, and which has not been used for twenty-five years, has been cut out and the brush burned, thereby giving us access to about 2,500 acres of land.

Several camp sites have been leased and one new camp erected on College Pond. Three new camps are partially completed, one each on Widgeon, Rocky and Clew ponds. A telephone line was built from the superintendent's house to College Pond, a distance of 3 miles, which is very necessary in case of a fire on the reservation or during planting season, when we are employing several men on that end of the forest. Several miles of highway have been repaired, making the reservation more accessible to automobilists. A new cement foundation was constructed under the superintendent's house in order that this might be used through the entire year. Two hundred and eighty-five thousand seedlings were planted on the reservation at a cost of $10.73 per thousand.

Savoy State Forest.

About 12 miles of brush have been cut and disposed of and 4½ miles of road repaired. One hundred and thirty thousand trees were planted on this reservation at a cost of $6.72 per thousand.

Otter River State Forest.

The brush on about 12 miles of boundary line, roadway and fire lines has been cut and burned. A large amount of ditching was done in order to dry out the old abandoned railroad bed, making it suitable for use as a road and at the same time as a fire line. The barn was repaired by installing new sills and planking the floors, and exterior and interior repairs were made on the house. A telephone line was built connecting the reservation house with the New England Telephone and Tele-

graph Company's line. Twelve acres of brush were cut and burned preparatory to spring planting. A new bridge was constructed across Otter River, and a trail cut to King Philip's Rock. Two hundred and thirty-seven thousand trees were planted at a cost of $9.89 per thousand.

Mount Grace State Forest.

One-half mile of road was built at the base of the mountain. Twenty-four acres of brush were cut, releasing the young pine. A lean-to or open-air camp, 8½ by 12 feet, was constructed at the summit of Mount Grace, and the Weeks house and barn were partially repaired so that they might be suitable for survey crews to use while working in that locality.

Conway State Forest.

Three and one-half miles of road were repaired on this reservation and 100,000 trees were planted at a cost of $11.20 per thousand.

Wendell State Forest.

Four miles of road were cleared and the brush piled ready for burning. Two new bridges were constructed to replace the old ones that were unusable.

Erving State Forest.

The road leading from the main highway to Laurel Lake was brushed and burned to a width of 45 feet. A 40-acre tract was prepared for spring planting by cutting and disposing of the brush. Thirty thousand trees were planted at a cost of $10.65 per thousand.

Swann Forest.

Three miles of wood road were brushed and burned. A 60-foot bridge was replanked and considerable work done on the buildings. Seventy-nine thousand three hundred trees were planted at a cost of $7.80 per thousand.

Tolland State Forest.

Eleven and one-half miles of road and trail have been brushed out and burned. One foot bridge and one wagon bridge were

constructed. The McGrannis house was put in condition for housing men during the spring tree planting, and later in the fall was further repaired and painted. One hundred and three thousand, eight hundred trees were planted at a cost of $13.62 per thousand.

Colrain State Forest.

Two hundred thousand trees were planted at a cost of $18 per thousand, which included the cost of the trees. This work was done by the Franklin Forestry Company, who were able to plant and furnish trees at this low price, as they had a surplus in their nursery, situated near by in the town of Colrain. They also did some necessary brush cutting at a contract price.

Harold Parker State Forest.

Thirty thousand trees were planted at a cost of $9.57 per thousand.

The present area of the State forests to date, Nov. 30, 1921, is given in tabular form below: —

Name of Forest.	Acreage.
Arthur Warton Swann State Forest	986.75
Bear Mountain State Forest	5,174.00
Colrain State Forest	501.00[1] 294.80
Conway State Forest	666.00
Erving State Forest	1,595.40
Harold Parker State Forest	1,222.60
Mohawk Trail State Forest	3,281.00
Mount Grace State Forest	994.375
Myles Standish State Forest	7,464.00
Otter River State Forest	1,720.75
Sandwich State Forest	507.34
Savoy Mountain State Forest	3,998.90
Tolland State Forest	2,925.00
Wendell State Forest	2,124.27
Total	33,456.185

[1] This acreage was acquired under the so-called reforestation act, section 10, chapter 132, General Laws.

This total acreage of 33,456.185 has been purchased at a total cost of $207,287.43. Of this amount $42,650 has been expended on the purchase of Mount Grace and $50,625 on the purchase of the Mohawk Trail, in accordance with the provisions of chapter 344, Acts of 1921, and chapter 606, Acts of 1920.

REPORT OF THE STATE FIRE WARDEN.

Mr. W. A. L. Bazeley, *State Forester.*

Sir: — In compliance with your request, and in accord with the provisions of section 28, chapter 48 of the General Laws, I beg to submit the following report of the work accomplished by this branch of the Division this year.

With the exception of the extreme drought throughout the spring months, and the short drought preceding the hunting period, the season has been a comparatively favorable one.

With very little snow during the preceding winter, fires started early in March, necessitating the opening of our observation stations nearly three weeks in advance of former years. Very little rain had fallen during this period until about May 25. This condition, together with the high March and April winds, made ideal conditions for forest fires, and we feel that we are extremely fortunate in holding our loss at a low mark as compared with losses sustained in other New England States.

With practically no rain for a month before the opening of the hunting season October 18, and with reports coming in from over the entire State requesting the closing of the hunting season, the matter was called to the attention of the Governor, and the following statement was issued by him: —

Commissioner of Conservation Bazeley has received reports from the game wardens throughout the Commonwealth. Without exception they believe that unless the open season on upland shooting is suspended there is the gravest danger of forest fires. However, there are no large fires raging to-day, and Governor Cox has decided not to interfere with the open season at present. He urges all hunters to use extreme care in preventing fires, and has announced that if any considerable number of forest fires are started, even on the first open day, he will then be obliged to suspend the season on all shooting until after drenching rains have fallen.

With a heavy downpour of rain the night before the opening, and with occasional rains throughout the following weeks, to-

gether with the hearty co-operation of the hunters, no severe fires were experienced.

The most disastrous fire of the season was a New York, New Haven & Hartford Railroad fire, which occurred in Medfield, May 21, burning over about 1,500 acres and causing a damage exceeding $20,000. This fire was fanned by a 50-mile gale, which made it almost impossible to extinguish.

The transferring to this branch of the Division of all State forests acquired by the Department has necessarily increased the duties of the district forest wardens, as all State lands within their districts are placed under their immediate supervision. As most of the new purchases were confined to the northern and western parts of the State, it was found necessary to divide districts 4 and 5, creating a new district including the northern part of Worcester County and all of Franklin County. Mr. Joseph L. Peabody of Winchendon, who has been associated with this Department for a number of years as caretaker of the Otter River Reservation, was appointed district forest warden of this district. No other changes have been made in the districts, but as additional lands are acquired, it will probably become necessary to reduce the size of some of the other districts.

Under date of May 14, Governor Cox issued the following proclamation, setting apart the week of May 22 to 28 as forest protection week: —

THE COMMONWEALTH OF MASSACHUSETTS.

By His Excellency CHANNING H. COX, Governor.

A PROCLAMATION.

FOREST PROTECTION AND FIRE PREVENTION WEEK.

The President of the United States has asked the various States of the Union to observe the week of May 22–28, 1921, as Forest Protection Week, and has requested citizens generally to observe this week in such a manner as may call public attention to the tremendous and unnecessary waste caused by forest fires and the need for definite, well-planned action that may materially reduce the annual loss from this cause.

On May 15 the total loss from forest fires in this Commonwealth alone had been over sixty-two thousand dollars, which is in excess of the total loss for the whole of the previous year. Not only is there a waste of timber, but hundreds of wild birds and animals are destroyed in every such fire.

Therefore I recommend that the citizens of every community make individual and collective effort this year to prevent forest fires, to the

end that we may protect the timber, the wild life and the natural scenery of Massachusetts.

Given at the Executive Chamber, in Boston, this fourteenth day of May, in the year of our Lord one thousand nine hundred and twenty-one, and of the Independence of the United States of America the one hundred and forty-fifth.

CHANNING H. COX.

By His Excellency the Governor.

FREDERICK W. COOK,
Secretary of the Commonwealth.

At this time 5,000 copies of a bulletin entitled "Safeguarding America Against Fire" were sent out over the entire State. In addition to this, nearly 1,000 Boy Scouts throughout the State responded to an invitation extended by the Commissioner and visited the observation towers in their localities Saturday, May 28. There they learned what Massachusetts is doing to lessen the damage caused by forest fires. At each station speakers were provided, giving the boys a talk on fire prevention.

During the months of February and March, forest fire conferences were held at Middleborough, Boston, Worcester, Greenfield, Springfield and Pittsfield. Forest wardens, selectmen, railroad officials and Boy Scouts executives attended these meetings. The conferences were very instructive and a great deal of interest was shown. Every railroad was represented, having from six to twelve men in attendance, covering every branch of their work bearing on railroad fires. Through the courtesy of Mr. E. A. Ryder of the Boston & Maine Railroad, a model locomotive was loaned us for use at each meeting. Mechanics in attendance at the different meetings explained the construction and workings of the spark arrester and ash pan; also the travel of a cinder from the time it leaves the fire box until it goes out of the stack, showing the importance of keeping the spark arresters and ash pans in perfect condition.

The Boy Scout movement as an aid to fire prevention was a very interesting topic, and it is pleasing to know that to-day Boy Scouts, as well as many other boys throughout the State, are being instructed by chiefs of fire departments and forest wardens in the method of charging and using fire extinguishers, and methods used in controlling forest fires.

Commissioner Bazeley gave a very interesting talk at each meeting on the "State Forest Policy," and told of the imperative

Fire observation tower on Oak Hill, Harvard; built in 1921. It completes our system of forty stations.

need of taking steps to insure the future timber supply of Massachusetts.

Mr. William C. Adams, Director of Fisheries and Game, gave a word of warning relative to the depletion of wild life by forest fires, bringing out the importance of protecting our woodlands from fire if we are to perpetuate the bird life of the State.

Many interesting discussions were held on ways and means of controlling fires, the enforcement of the slash law, and other matters pertaining to the enforcement of the fire laws.

A large amount of construction, repairs, painting and telephone work has been done by our district men and observers this season. Fourteen of our stations were repainted, new telephone lines were installed in six stations where it was necessary to erect new poles, and the old telephone lines were thoroughly repaired at twelve stations.

A new 70-foot tower was erected at the summit of Oak Hill in the town of Harvard. This will undoubtedly prove to be one of the most important stations we have, overlooking vast forested areas that we have been unable to protect by other stations. Several towns receiving protection from this tower contributed $1,350 towards the purchase price.

We have maintained 39 observation towers this year, and the observers are entitled to a great deal of credit for the promptness and accuracy shown in locating and reporting fires. More than 24,000 people have visited these stations during the season, coming from nearly every State in the Union and from many foreign countries. The trails leading to the towers have been cleaned and improved, thereby making the climb to the summit of the mountains much easier.

At the Mount Grace Station, in the town of Warwick, an open camp, 8½ by 12 feet, was constructed, and a stone and cement fireplace will be built in front of it as soon as weather conditions will allow in the spring. We anticipate that this camp and fireplace will be used a great deal by campers, and is the starting of a system of camps and fireplaces to be built at many of our stations.

An extra effort has been made this year to enforce the slash law. Our district men have devoted a large part of their time to this, and in most instances have met with prompt action on the part of the lumber and wood operators. The officials representing power lines and telephone companies have co-operated

with us, and many miles of their lines have been cleaned and the brush burned. A few town officials who have charge of roadside cutting have not been as active in carrying out the provisions of this law as we would desire, owing in some instances to the town finances, and in other cases to indifference on the part of the men having the immediate charge of the work, but the majority of towns have done exceptionally fine work in removing their brush and disposing of it.

Upon the request of Forester P. W. Ayers of the Society for the Protection of New Hampshire Forests, assistance was sent to Randolph, N. H., October 10, to aid in the extinguishing of a fire burning over the northern slope of Mount Madison. District Forest Wardens Crowe and Montle, with one of our large gasolene pumps and 750 feet of hose, arrived there at 3 A.M. the following day, and remained two days, when they returned, leaving the pump and equipment there for use. This pump proved very effective in holding the fire within the above area.

One of the unfortunate conditions we have always had to contend with is the allowing of portable sawmill operators the privilege of operating throughout the State without any restrictions whatever, and without any knowledge of when and where they are to operate. During the year we have had more than 260 of them in operation scattered over the entire State. Most of their operations are small, a matter of possibly four or five weeks, and then they move to other fields. Many of the operators come from adjoining States, complete their jobs and return, with absolutely no respect for the slash or spark arrester laws. As we have no means of knowing the location of any of their operations without going to considerable State expense, it seems advisable and for the best interests of the Commonwealth that the present portable sawmill act be amended, requiring all operators to file with this Department a statement setting forth when and where they are to operate, and also requiring them to dispose of all brush and slash within a certain distance of their mill locations. This would enable us to get in touch with them before their operations were commenced, and make sure that all laws relative to fire prevention were to be complied with. We would also be in a position to answer a large number of inquiries made by small timberland owners relative to the location of a mill in the vicinity of their woodlands, thus giving them an opportunity to dispose of their mature timber before the removal of the mill. This would also furnish additional business for the sawmills.

The permit law, which requires the procuring of a permit from the forest warden for starting open-air fires, has been very well observed, and more than 28,000 permits have been issued. While we have had some violations, they have in most cases come from lack of familiarity with the law. Fifteen persons have been convicted and fined and 73 persons have settled by paying the cost of extinguishment. One person was convicted for operating a portable sawmill without a screen.

The railroad fire situation, as far as it relates to the Boston & Albany and the New York, New Haven & Hartford railroads, does not show any decided improvement over previous years. In fact, these two roads have set more fires this year than in any previous year during a period of ten years. The following table gives a comparison of mileage, the number of locomotives in use, and the number of fires: —

Railroad.	Mileage.	Number of Locomotives.	Number of Fires.
New York, New Haven & Hartford . . .	1,883	922	471
Boston & Albany	979	354	292
Boston & Maine	2,017	1,025	95
Central Vermont	71	23	4

The above table shows that the Boston & Maine railroad, with the greatest number of locomotives, has caused but 95 fires, as compared with 471 by the New York, New Haven & Hartford, and 292 by the Boston & Albany. The reason for this marked improvement by the Boston & Maine is because they have made a special study of the railroad fire problem. They have kept their rights of way, and in many instances lands adjoining their rights of way, free from all inflammable material, and locomotives are not allowed to leave their yards or roundhouses unless they are in perfect condition. The Central Vermont Road, which at one time set as many as 65 fires on their short line, have practically eliminated them. This is due without doubt to their having to file with the Department of Public Utilities a report of the condition of every locomotive they operate in this State, and no locomotives are allowed to operate unless they are in perfect condition.

The enormous number of fires set by the Boston & Albany and by the New York, New Haven & Hartford railroads can be attrib-

uted to the fact that the officials of these roads do not make a careful study of their rights of way conditions, and allow locomotives to operate that should be in the shops for repairs. The fact is, they have no real fire preventive system. The mechanical department is responsible for the setting of the fires, and the claim department is responsible for the settling of fire claims, no united effort being made to ascertain the exact cause and then remedy it. The Department of Public Utilities and this Department have made over 4,000 special examinations of front ends and ash pans of locomotives of these two roads this year, and have found many defects which should have been discovered by the railroad employees and not by an employee of any State department.

For the past ten years this Department has co-operated with the railroads to the fullest possible extent in endeavoring to reduce the number of railroad fires, and the results accomplished are far from satisfactory. If the railroads are to allow such conditions to exist, there seems to be but one alternative, and that is to enact additional laws which would require a daily inspection of all front ends and ash pans of every locomotive in operation throughout forested areas; also, to require the patrolling of their right of way in such locations and at such times as designated by this Department, with a heavy penalty for the violation of any of the railroad forest fire laws.

Our records show that we have had 862 railroad fires, — the Boston & Albany, 292; the Boston & Maine, 95; the New York, New Haven & Hartford, 471; and the Central Vermont, 4. These fires burned over an area of 5,711 acres, with a cost to extinguish of $9,331, and a property loss of $40,531.

Twenty towns have purchased additional forest fire fighting equipment, taking advantage of the reimbursement act, which provides for the reimbursement to towns for one-half the expense of equipment.

Several wardens, realizing the advantage of motorized equipment for use at forest fires, have been able to procure sufficient appropriation from their towns for such, and a piece of motor apparatus has been added to their equipment.

We have co-operated again this year with the Federal Department under the Weeks Law, and were allotted $7,262.36 to be expended in fire protection work within the State.

Respectfully submitted,

M. C. Hutchins,
State Fire Warden.

COMPARATIVE DAMAGES BY FOREST FIRES FOR THE PAST TWELVE YEARS.

YEAR.	Number of Fires.	Acreage burned.	Cost to extinguish.	Damage.	Average Acreage per Fire.	Average Damage per Fire.
1910	1,385	42,221	$23,475	$205,383	30.46	$148 20
1911	2,356	99,693	47,093	537,749	39.31	226 24
1912	1,851	22,672	20,219	80,834	11.92	43 67
1913	2,688	53,826	35,456	178,357	20.02	66 35
1914	3,181	38,975	48,750	95,389	12.25	29 98
1915	3,008	48,389	36,783	141,073	16.08	46 90
1916	1,425	16,198	8,593	44,765	13.22	36 54
1917	2,175	20,020	18,033	41,109	9.21	18 90
1918	2,553	37,638	28,043	205,627	14.74	80 05
1919	1,566	22,045	17,388	49,069	14.07	31 32
1920	1,619	14,517	27,839	62,241	8.96	38 44
1921	2,849	29,221	34,065	121,790	10.25	42 75

TYPES OF CLASSIFIED DAMAGES.

	1917.	1918.	1919.	1920.	1921.
Standing trees	$24,705	$71,706	$16,595	$37,532	$50,554
Logs, lumber, cordwood	4,680	37,815	7,516	7,371	31,006
Buildings	6,893	46,025	12,508	11,950	10,035
Bridges, fences	687	1,742	902	285	1,050
Not classified	4,144	48,339	11,548	5,103	29,145
Totals	$41,109	$205,627	$49,069	$62,241	$121,790

TYPES OF LAND BURNED OVER (ACRES).

	1917.	1918.	1919.	1920.	1921.
Timber	1,237	2,520	1,659	1,077	2,232
Second growth	2,274	5,696	2,502	1,351	2,654
Second growth, not merchantable	4,137	6,069	2,893	2,224	4,912
Brush land	7,126	10,549	11,122	7,119	11,859
Grass land	3,814	4,669	3,671	2,119	4,467
Not classified	1,432	8,135	198	627	3,097
Totals	20,029	27,638	22,045	14,517	29,221

FOREST FIRES OF 1921.

MONTHS.	Number.	Acres.	Cost to extinguish.	Damage.
1920.				
December	20	61	$63 00	$20 00
1921.				
January	152	1,027	1,111 00	896 00
February	10	22	71 00	1,500 00
March	961	9,160	6,837 00	23,599 00
April	822	6,997	8,540 00	20,955 00
May	337	6,766	7,301 00	60,651 00
June	281	2,339	6,260 00	8,329 00
July	15	19	97 00	12 00
August	35	104	262 00	325 00
September	63	383	1,008 00	370 00
October	140	2,313	2,398 00	5,063 00
November	13	30	87 00	50 00
Totals	2,849	29,221	$34,065 00	$121,790 00

CLASSIFIED CAUSES OF FOREST FIRES, 1916–21.

	1916.		1917.		1918.		1919.		1920.		1921.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Railroad	412	42.1	800	36.8	799	31.2	549	35.1	614	37.9	862	30.25
Lumbering	2	.2	5	.2	14	.6	5	.3	4	.2	4	.14
Brush burning	79	8.1	262	12.0	300	11.7	204	13.0	155	9.6	327	11.48
Campers	146	14.9	357	16.4	403	15.6	239	15.3	251	15.5	12	.42
Incendiary	–	–	–	–	–	–	–	–	13	.8	52	1.83
Miscellaneous	38	3.9	117	5.4	111	4.7	70	4.5	50	3.1	537	18.85
Unknown	301	30.8	634	29.2	926	36.2	499	31.8	532	32.9	1,055	37.03
Totals	978	100.0	2,175	100.0	2,553	100.0	1,566	100.0	1,619	100.0	2,849	100.00

TOWNS RECEIVING FIRE-EQUIPMENT REIMBURSEMENT DURING 1921.

Ashburnham	$6 25	Gosnold	$69 80
Avon	119 00	Hancock	60 55
Boxford	37 50	Middleton	6 25
Brookfield	62 25	New Braintree	85 75
Burlington	21 70	Pelham	37 50
Cummington	2 37	Richmond	54 25
Dennis	5 13	Sterling	7 55
Eastham	29 75	Wellfleet	92 00
Enfield	6 25		
Freetown	5 85	Total	$715 70
Georgetown	6 00		

REPORT OF THE SUPERINTENDENT OF MOTH WORK.

Mr. WILLIAM A. L. BAZELEY, *State Forester.*

SIR: — Pursuant to your request, I have the honor to submit for your information a brief report of the operations carried on against the gypsy and brown-tail moths for the fiscal year ending Nov. 30, 1921. The methods used in handling the moth problem this year have been practically the same as in past years, namely, creosoting followed by spraying. We find this the cheapest and most efficient way of carrying on the work. The co-operation of the town authorities and the people in general — with the exception of a few towns where the citizens did not attend town meetings and appropriate funds enough to do the necessary work — has been very gratifying. We hope for better co-operation next year, particularly in respect to the willingness of towns to appropriate funds.

GENERAL CONDITIONS.

I am pleased to say that the gypsy-moth infestation is not as severe this fall as a year ago, although in a few towns there is a heavy egg deposit. Conditions as a whole show an improvement.

SUMMARY OF CONDITIONS BY DIVISIONS.

Mr. Fitzgerald's division showed conditions about normal in regard to the gypsy moth, some woodland stripping, but the residential sections all kept in good condition by spraying. The brown-tail moth was more prevalent towards the New Hampshire line, but thorough cutting of the webs prevented much damage. The wilt disease of the gypsy moth though late was effective.

In Mr. Hatch's division the brown-tail moth was plentiful along the New Hampshire line, particularly in Pepperell, but thorough exterminative work was done along the border. The gypsy-moth infestation was heavy, and in some towns, notably, Lincoln, Ashland, Concord, Weston and Bolton, from 75 to 150 acres were stripped. But in these towns a large decrease in nests was observed in the fall. The State highways in this division were sprayed by the State truck sprayers and the foliage preserved.

Mr. Donovan's division showed a general heavy infestation of gypsy moths, with the exception of Winthrop, which is fairly free from the insects. The towns all hold the insect in check well with the exception of Topsfield, which badly needs a large sprayer. The State helped as much as possible with the dusting machine and a power sprayer, but in order to keep the town trees in good condition a large spraying machine is absolutely necessary, and the town should provide means for acquiring one. The infestation of gypsy moth in the Lynn woods was exceptionally severe this fall, probably owing to reinfestation from the water board property. To overcome this bad condition a large amount of creosoting was done this fall, and all the worst localities will be sprayed next summer.

Mr. Parkhurst's division is generally infested, and has many outlying towns where the seriousness of the problem and the necessity for appropriating money are not appreciated. The towns of Acushnet, Avon, Dighton, Franklin, Medway, Somerset and Walpole need large sprayers badly. Fortunately, Somerset has little woodland, and Franklin has a small sprayer, but the large sprayers are a necessity now in every town. Berkley is mostly woodland and is badly infested. Freetown is in much better condition than ever before, and another good year of work like the last should put it in first-class condition. In Mansfield a great improvement has been made under the new town manager. In Norton and Plainville conditions are improved, but Randolph has not come up to the standard of good work. The local superintendent is too busy on other things and the townspeople do not co-operate. The city of Taunton should appropriate more money. Conditions are getting bad in Westport and more money should be appropriated there.

In Mr. Ramsey's division the brown-tail moth was found in large numbers in Northborough, Southborough and Westborough, and was present in other towns. The wilt disease of the gypsy

moth was observed late but was very effective. In Oxford, Milford and Upton the gypsy moth is on the increase, and more careful work should be done by the local officials, and we should like to see more interest in the matter on the part of both officials and citizens. Poor work is done in Westborough, and in Templeton the number of the moths has increased, owing, perhaps, to the fact that the local superintendent now lives out of town. Mr. Ramsey reports the recurrence of the elm leaf beetle in the Connecticut River district, and also in some Worcester County towns.

Better work against the gypsy moth should be done at the State institutions and reservations, particularly Westborough State Hospital and the Wachusett Mountain Reservation. All towns east of the Connecticut River are now infested, and the following towns west of the river were infested on December 1: —

Agawam.	Heath.
Bernardston.	Holyoke.
Chester.	Huntington.
Colrain.	Leyden.
Deerfield.	Rowe.
Easthampton.	Shelburne.
Gill.	Southampton.
Granville.	Westhampton.
Greenfield.	West Springfield.

The Federal government, which has maintained a quarantine belt in Worcester County for years, has now carried westward this belt, giving up to State control 24 towns. These towns will have to raise money to meet the obligations of the law, but it will probably not be forthcoming until February or March town meetings. This will leave a very short time in the season, when traveling is hard in the country, to do all the necessary work in these towns. Should the government carry this quarantine belt as far west as the Connecticut River the sixth district would probably be too large for one man to handle.

Mr. Holmes reports conditions somewhat as usual in his division, as improvements in one section are perhaps counteracted by conditions in others. Towns needing more and better equipment for spraying are Bourne (a large town needing two more spraying machines), Hanson and Lakeville. The towns of Edgartown and Chilmark should appropriate more money and do thorough scouting and suppressive work. The town of Duxbury

cut appropriations down last year to a minimum and did no private spraying, and but for good work done in the past the town would have been in bad condition this fall. The officials appreciate the situation, but the townspeople are indifferent. Both Mattapoisett and Rochester should appropriate more funds for this work.

Federal Gypsy Moth Work in Massachusetts.

The Federal work has continued during the past year as usual, the only changes being those incident to delayed and reduced appropriations. The report of Mr. A. F. Burgess, the agent in charge of moth work, is herewith given in full: —

Owing to drastic reduction in the Federal appropriation for this work, and because a very heavily infested area was found in New Jersey during the summer of 1920, it was necessary to revise the plans for fall work and to request a deficiency appropriation so that this work could be continued vigorously both in New Jersey and along the entire infested border in New England. On account of lack of funds the work on the infested border had to be discontinued Dec. 1, 1920, and owing to protracted delay in the deficiency funds becoming available it was not possible to resume this work until about March 15 the following spring.

Scouting was done from that time until the eggs began to hatch, but as the season was very early, only about a month was available for scouting work. Several additional infested towns were found, but many that should have been scouted could not be given attention because sufficient experienced men could not be secured to carry on the work in the limited time that remained. During the spring most of the towns in the area heretofore treated by the Bureau were given attention. A considerable amount of spraying was carried on in badly infested localities, both in this area and in a number of towns towards the east.

The fall scouting work was organized by dividing the Massachusetts border territory into two sections with a general foreman in charge of each, with headquarters at Greenfield and Springfield, respectively. Scouting was begun early in the fall, but the maximum number of crews that it was planned to use were not available until late in November, when it was possible to transfer some from areas farther north.

The result of the scouting thus far indicates scattered infestations in many towns west of the known infested area, and at the present writing scouting work is not nearly completed. Several towns in the Berkshires have been found slightly infested, particularly in the northern part of the State. The infestation is light in all cases, but sufficient work has been done to indicate that the discontinuance of field work last year has made possible much additional spread of the insect. Since 1913 the

Bureau has been carrying on scouting and control work in Massachusetts west of a line running across the State in a somewhat north and south direction, immediately west of Worcester. This belt of towns has increased gradually from year to year.

With the funds available, it is impossible to carefully scout and treat an area much greater than 25 miles in width along the border. If this work is thoroughly and systematically done, it is believed that reasonable protection from the spread of the insect will be afforded other States to the westward. Under these conditions it is necessary for the State to make arrangements to take care of the treatment of towns which can no longer be handled by the Bureau.

The infestation during the past year, particularly in towns between Boston and Worcester, was unusually severe and heavy defoliation resulted in many areas. Introduced parasites were found in many sections of the territory, and some of these species were more abundant than usual. The fact remains, however, that in most of these areas the introduced parasites were not abundant enough to bring about effective control.

A considerable amount of foreign work has been done by the Bureau looking to the establishment of all parasites or natural enemies of the gypsy moth that may be useful in this country. This work was interrupted during the war, but arrangements have now been made to send experts to Europe and Japan to make further studies of the natural control of this insect in these countries, and to ship to the Melrose Highlands Laboratory as much parasitized material as possible. This work will be taken up at once, and it is hoped that substantial progress will be made along this line within the next few years.

Special North Shore Work.

Woodland work was carried on this year under the co-operative fund in the same way as usual, the creosoting and spraying being done only where it was necessary, thus using only a small part of the fund. No signs of feeding were noticed where work was done. A total acreage of 2,754 was creosoted and 1,230 acres were sprayed. Six and one-half miles of State highway trees in the city of Gloucester and 5½ miles in the city of Beverly were creosoted and sprayed. A financial statement showing the present status of the fund is here given. In addition to the balance now on hand the sum of $900.69 has been collected for work done on private estates and will be added to the fund by Col. William D. Sohier, the agent of the residents co-operating, within a few days.

FINANCIAL STATEMENT.

Receipts.

Balance from 1920		$18,209 26
Massachusetts Highway Division		176 41
State Forester, for work done		483 93
		$18,869 60

Expenditures.

Services	$5,341 81	
Travel	84 68	
Supplies	4,364 63	
Sundries	449 67	
Rent	420 00	
Telephone	76 80	
		10,737 59
Balance on hand Nov. 30, 1921		$8,132 01

Respectfully submitted,

GEORGE A. SMITH,
Superintendent of Moth Work.

APPENDIX

APPENDIX.

FINANCIAL STATEMENT.

EXPENDITURES.

Appropriation (c. 203, Acts of 1921), salary of Commissioner	$5,000 00		
Appropriation (c. 203, Acts of 1921), personal services	10,500 00		
		$15,500 00	
Expenditures		15,470 00	$15,470 00
Appropriation (c. 203, Acts of 1921), office incidentals	$5,500 00		
Appropriation (c. 203, Acts of 1921), expenses of Commissioner	250 00		
		5,750 00	
Expenditures		4,852 20	4,852 20
Appropriation (c. 203, Acts of 1921), general forestry and nurseries	$13,000 00		
Amount brought forward from 1920	2 93		
		13,002 93	
Expenditures		12,997 48	12,997 48
Appropriation (c. 203, Acts of 1921), purchase and planting of forest lands		10,000 00	
Expenditures		8,058 29	8,058 29
Appropriation (c. 203, Acts of 1921), prevention of forest fires	$40,000 00		
Federal appropriation	2,500 00		
Appropriation (c. 502, Acts of 1921), prevention of forest fires	6,000 00		
Federal allotment	4,762 36		
		53,262 36	
Expenditures		53,262 29	53,262 29
Appropriation (c. 203, Acts of 1921), protection against forest fires		1,000 00	
Expenditures		715 70	715 70
Appropriation (c. 203, Acts of 1921), for reimbursement for fighting forest fires		1,000 00	
Expenditures		–	–
Appropriation (c. 203, Acts of 1921), suppression of gypsy and brown-tail moths	$210,000 00		
Balance from 1920	47,056 36		
Refunds and transfers	1,037 84		
		258,094 20	
Expenditures		181,957 92	181,957 92
Appropriation (c. 203, Acts of 1921), maintenance of forests		25,000 00	
Expenditures		24,974 99	24,974 99

Appropriation (c. 203, Acts of 1921), purchase and development of State forests	$175,000 00		
Balance from 1920	22,475 67		
		$197,475 67	
Expenditures		131,755 39	$131,755 39
Appropriation (c. 203, Acts of 1921), maintenance of nurseries		25,000 00	
Expenditures		18,841 38	18,841 38
Appropriation (c. 203, Acts of 1921), maintenance of Mount Grace	$1,000 00		
Balance for purchase of Mount Grace from 1920	29,750 00		
		30,750 00	
Expenditures		26,030 80	26,030 80
Appropriation (c. 203, Acts of 1921), maintenance of Standish Monument Reservation		3,000 00	
Expenditures		2,993 42	2,993 42
Total expenditures for 1921			$481,909 86

Receipts.

For cordwood and logs sold	$45 12
For trees sold	147 51
For forest examinations	950 15
For sale of land	393 90
For damage by fire	540 00
For camp sites	201 00
For sale of old engine	25 00
For rent, hay, pasturage, etc.	524 80
For lumber sold (Swann operation)	4,698 64
For supplies and gypsy moth work	30,089 94
For supplies for fire fighting	2,108 56
For fire towers	1,150 00
Total for year	$40,874 62

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921.

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Abington	$1,607 74	-	-	-	$1 50	-	$1,714 24
Acton	965 67	$974 61	$681 65[1] 91 50	-	1,101 16	$1,101 16	980 39
Acushnet	1,035 66	-	-	-	-	-	1,155 10
Adams	4,265 66	-	-	-	-	-	4,241 81
Agawam	2,002 29	-	-	-	-	-	2,090 01
Amesbury	4,077 56	-	-	-	-	-	4,067 33
Amherst	2,872 32	-	-	-	-	-	2,980 58
Andover	4,036 03	-	-	-	-	-	4,391 45
Arlington	5,000 00	-	-	-	-	-	5,000 00
Ashburnham	584 69	988 46	38 00[1] 104 40	$403 77	177 60	581 37	568 04
Ashby	304 74	531 97	432 83[1] -	227 23	608 75	835 98	348 81
Ashland	835 00	1,378 75	23 18[1] 98 00	543 75	191 18	734 93	829 26
Athol	3,476 53	-	-	-	-	-	3,652 50
Attleboro	5,000 00	-	-	-	-	-	5,000 00
Auburn	968 96	572 48	196 92	-	-	-	1,057 92
Avon	558 54	626 00	78 10	67 46	108 30	175 76	571 81
Ayer	1,222 13	-	-	-	42 04	-	1,257 91
Barnstable	4,072 83	-	-	-	-	-	4,268 48
Barre	1,248 91	-	-	-	-	-	1,305 93
Bedford	915 33	1,970 98	57 52[1] 1,049 41	1,055 65	1,089 46	2,145 11	923 62
Belchertown	471 59	-	-	-	-	-	484 83
Bellingham	610 91	-	-	-	-	-	672 59
Belmont	5,000 00	-	-	-	-	-	5,000 00
Berkley	294 29	385 40	73 00	91 11	109 80	200 91	293 65
Berlin	347 04	1,019 97	93 90[1] 402 87	672 93	363 02	1,035 95	357 16
Bernardston	257 64	-	-	-	-	-	261 30
Beverly	5,000 00	-	-	-	-	-	5,000 00
Billerica	2,746 18	-	-	-	-	-	2,802 52
Blackstone	850 99	-	-	-	-	-	893 00
Bolton	336 91	318 48	568 84	-	1,247 80	1,229 37	340 38
Boston	5,000 00	-	-	-	-	-	5,000 00
Bourne	2,500 30	-	-	-	-	-	2,259 54

[1] Lead sold.

TABLE SHOWING EXPENDITURES AMD REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Boxborough	$140 66	$178 22	$390 83[1] 36 00	$37 56	$637 33	$674 89	$136 65
Boxford	397 64	1,194 59	194 00[1] 552 37	796 95	753 80	1,550 75	409 45
Boylston	259 72	1,176 95	637 04	917 23	432 86	1,350 09	267 54
Braintree	4,445 23	–	–	–	–	–	4,819 95
Brewster	447 65	692 88	45 52[1] 388 30	245 23	320 79	566 02	447 52
Bridgewater	1,901 56	2,112 91	113 04[1] 1,618 27	211 35	1,223 68	1,435 03	1,931 95
Brimfield	380 99	–	–	–	–	–	386 97
Brockton	5,000 00	–	–	–	–	–	5,000 00
Brookfield	707 44	–	–	–	–	–	437 15
Brookline	5,000 00	–	–	–	–	–	5,000 00
Burlington	569 64	564 33	276 05	–	698 44	693 13	583 77
Cambridge	5,000 00	–	–	–	–	–	5,000 00
Canton	2,750 11	–	–	–	–	–	2,754 58
Carlisle	233 55	1,952 59	124 80[1] 615 16	1,719 04	747 82	2,466 86	239 04
Carver	849 99	1,342 17	550 11[1] 2,307 29	492 19	2,403 00	2,895 19	896 71
Charlton	655 97	–	–	–	–	–	651 34
Chatham	1,118 99	–	–	–	11 96	–	1,270 12
Chelmsford	2,568 82	–	–	–	109 72	–	2,634 22
Chelsea	5,000 00	–	–	–	–	–	5,000 00
Chester	–	–	–	–	–	–	412 90
Chicopee	5,000 00	–	–	–	–	–	5,000 00
Chilmark	183 25	–	–	–	–	–	187 35
Clarksburg	203 05	–	–	–	–	–	228 97
Clinton	4,712 00	–	–	–	–	–	5,000 00
Cohasset	2,674 26	–	–	–	–	–	2,717 14
Colrain	466 94	–	–	–	–	–	550 55
Concord	2,936 04	–	–	–	–	–	2,999 99
Dana	214 84	–	–	–	–	–	256 44
Danvers	3,480 12	–	–	–	–	–	3,542 64
Dartmouth	2,959 79	–	–	–	–	–	3,247 84
Dedham	5,000 00	–	–	–	–	–	5,000 00
Deerfield	1,715 62	–	–	–	–	–	1,806 27

[1] Lead sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Dennis	$606 97	$368 56	$112 50[1], 165 00	$261 59	$531 38	$792 97	$631 93
Dighton	1,189 45	–	–	–	–	–	1,260 45
Douglas	662 69	–	–	–	–	–	623 47
Dover	1,120 29	1,530 87	2,492 79	410 58	1,054 85	1,465 43	1,170 31
Dracut	1,326 47	2,306 76	985 10	960 29	1,259 05	2,239 34	1,334 72
Dudley	1,259 20	–	–	–	–	–	1,322 89
Dunstable	174 19	675 71	357 10	501 52	213 69	715 21	172 46
Duxbury	1,693 03	1,770 53	633 26	77 50	1,299 95	1,377 45	1,741 14
East Brookfield	–	–	–	–	–	–	328 54
East Bridgewater	1,445 79	1,644 84	1,097 98	199 05	999 71	1,198 76	1,560 53
East Longmeadow	794 81	–	–	–	–	–	829 00
Eastham	236 52	667 47	100 00	430 95	128 52	559 47	245 50
Easthampton	5,000 00	–	–	–	–	–	5,000 00
Easton	1,799 03	2,847 71	84 00[1], 960 84	1,048 68	1,824 74	2,873 42	1,875 29
Edgartown	718 81	–	–	–	–	–	792 61
Enfield	270 10	–	–	–	–	–	305 09
Erving	734 73	–	–	–	–	–	749 16
Essex	548 41	517 79	815 50	–	307 51	276 89	539 51
Everett	5,000 00	–	–	–	–	–	5,000 00
Fairhaven	3,145 65	–	–	–	–	–	3,414 99
Fall River	5,000 00	–	–	–	–	–	5,000 00
Falmouth	3,066 10	–	–	–	–	–	4,568 71
Fitchburg	5,000 00	–	–	–	–	–	5,000 00
Foxborough	1,265 29	1,465 97	451 61	17 30	857 98	1,058 66	1,283 03
Framingham	5,000 00	–	–	–	–	–	5,000 00
Franklin	2,586 19	–	–	–	–	–	2,595 94
Freetown	554 96	733 16	194 74	178 20	376 42	554 62	582 35
Gardner	5,000 00	–	–	–	–	–	5,000 00
Georgetown	599 16	1,435 55	62 14[1], 977 50	836 39	1,149 87	1,986 26	612 41
Gill	285 04	–	–	–	–	–	297 29
Gloucester	5,000 00	–	–	–	–	–	5,000 00
Grafton	1,519 98	–	–	–	–	–	1,963 95

[1] Lead sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Granby	$355 53	–	–	–	–	–	$352 42
Granville	–	–	–	–	–	–	251 27
Great Barrington	3,269 40	–	–	–	–	–	3,410 72
Greenfield	5,000 00	–	–	–	–	–	5,000 00
Greenwich	156 96	–	–	–	–	–	230 64
Groton	1,278 48	$1,669 94	$359 84[1]; 69 45[2]; 374 70	$391 46	$862 66	$1,254 12	1,318 83
Groveland	645 72	1,230 22	105 00[1]; 888 85	584 50	424 13	1,008 63	658 21
Hadley	1,193 00	–	–	–	–	–	1,172 93
Halifax	376 46	800 58	61 09[1]; 790 31	424 12	476 23	900 35	376 71
Hamilton	1,701 12	–	–	–	12 95	–	1,764 04
Hampden	–	–	–	–	–	–	197 92
Hanover	934 29	2,197 70	93 00[1]; 954 88	1,263 41	1,522 14	2,785 55	968 39
Hanson	834 11	1,131 86	57 76[1]; 878 10	297 75	694 82	992 57	848 29
Hardwick	1,327 40	–	–	–	–	–	1,342 62
Harvard	821 33	1,065 71	97 50[2]; 271 87	244 38	1,436 42	1,680 80	824 35
Harwich	874 76	1,731 52	117 61[1]; 1,368 91	856 76	1,197 12	2,053 88	949 56
Haverhill	5,000 00	–	–	–	–	–	5,000 00
Heath	–	–	–	–	–	–	126 93
Hingham	3,568 59	–	–	–	–	–	3,683 33
Holbrook	854 03	979 44	419 00	125 41	121 91	247 32	946 24
Holden	1,020 30	1,155 73	91 08[1]; 333 20	135 43	495 20	630 63	1,032 84
Holland	67 39	–	–	–	–	–	67 45
Holliston	1,031 15	919 45	153 00[1]; 703 98	–	494 02	382 32	1,061 34
Holyoke	5,000 00	–	–	–	–	–	5,000 00
Hopedale	1,359 06	–	–	–	–	–	1,388 59
Hopkinton	839 89	946 44	96 40[1]; 238 75	106 55	389 07	495 62	844 78
Hubbardston	354 30	–	–	–	–	–	419 73
Hudson	2,330 98	–	–	–	–	–	2,417 41
Hull	5,000 00	–	–	–	–	–	5,000 00
Huntington	–	–	–	–	–	–	415 15
Ipswich	2,422 77	–	–	–	72 51	–	2,521 93
Kingston	748 79	745 89	120 65[1]; 907 01	–	236 76	233 86	789 74

[1] Lead sold. [2] Supplies sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Lakeville	$514 37	$675 72	$76 10[1] 270 91	$161 35	$547 62	$708 97	$529 98
Lancaster	1,033 70	–	–	–	–	–	1,077 32
Lawrence	5,000 00	–	–	–	–	–	5,000 00
Leicester	1,131 73	–	–	–	–	–	1,153 67
Lenox	2,951 37	–	–	–	–	–	2,860 62
Leominster	5,000 00	–	–	–	–	–	5,000 00
Leverett	180 11	–	–	–	–	–	179 56
Lexington	3,984 16	–	–	–	–	–	4,105 52
Leyden	114 00	–	–	–	–	–	113 44
Lincoln	802 43	958 38	1,483 62	–	2,001 44	2,001 44	877 06
Littleton	653 39	293 35	702 74[1] 101 50	–	1,010 75	650 71	674 68
Longmeadow	–	–	–	–	–	–	2,272 77
Lowell	5,000 00	–	–	–	–	–	5,000 00
Ludlow	3,371 05	–	–	–	–	–	3,526 77
Lunenburg	746 25	802 31	1,174 85	56 05	1,038 13	1,094 18	739 40
Lynn	5,000 00	–	–	–	–	–	5,000 00
Lynnfield	791 71	1,630 61	639 65	864 40	1,100 86	1,965 26	824 03
Malden	5,000 00	–	–	–	–	–	5,000 00
Manchester	4,622 88	–	–	–	–	–	4,723 39
Mansfield	2,538 48	–	–	–	–	–	2,533 52
Marblehead	4,753 19	–	–	–	–	–	5,000 00
Marion	1,334 63	1,314 73	682 40	–	1,453 13	1,433 13	1,365 86
Marlborough	5,000 00	–	–	–	–	–	5,000 00
Marshfield	1,210 29	1,210 49	60 12[1] 2,383 66	–	1,787 15	1,787 15	1,350 71
Mashpee	200 58	1,750 13	460 14	1,549 55	420 86	1,970 41	213 44
Mattapoisett	857 31	–	–	–	–	–	847 62
Maynard	2,081 30	–	–	–	–	–	2,114 80
Medfield	883 76	1,772 87	35 70[1] 948 00	889 11	827 49	1,716 60	890 47
Medford	5,000 00	–	–	–	–	–	5,000 00
Medway	963 06	–	–	–	–	–	996 76
Melrose	5,000 00	–	–	–	–	–	5,000 00
Mendon	325 14	–	–	–	–	–	361 20

[1] Lead sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Merrimac	$693 48	$1,278 02	$27 50[1] 374 73	$584 54	$409 73	$994 27	$713 44
Methuen	5,000 00	–	–	–	–	–	5,000 00
Middleborough	2,366 69	2,941 43	1,523 11	574 74	963 47	1,538 21	2,791 62
Middleton	448 63	892 22	100 00[1] 501 50	443 59	424 86	868 45	461 41
Milford	4,823 13	–	–	–	–	–	4,880 93
Millbury	1,750 05	–	–	–	–	–	1,795 86
Millis	820 64	–	–	–	17 00	–	834 11
Millville	531 25	–	–	–	–	–	539 29
Milton	5,000 00	–	–	–	–	–	5,000 00
Monson	536 12	–	–	–	–	–	834 50
Montague	3,671 42	–	–	–	–	–	3,767 16
Nahant	1,670 01	–	–	–	–	–	1,724 62
Nantucket	2,266 05	–	–	–	–	–	2,366 95
Natick	3,904 07	–	–	–	–	–	3,968 45
Needham	4,336 06	–	–	–	–	–	4,565 42
New Bedford	5,000 00	–	–	–	–	–	5,000 00
New Braintree	203 83	–	–	–	–	–	211 66
New Salem	208 94	–	–	–	–	–	212 84
Newbury	649 81	1,613 20	484 66[1] 1,311 41	963 39	1,253 87	2,217 26	719 13
Newburyport	4,775 56	–	–	–	–	–	4,887 77
Newton	5,000 00	–	–	–	–	–	5,000 00
Norfolk	532 17	983 05	25 92[1] 293 50	450 88	551 17	1,002 05	542 03
North Andover	2,964 99	–	–	–	–	–	3,145 36
North Attleborough	3,453 37	–	–	–	–	–	3,541 25
North Brookfield	878 56	–	–	–	–	–	887 54
North Reading	607 14	1,221 84	705 62	614 70	1,127 73	1,742 43	635 73
Northampton	5,000 00	–	–	–	–	–	5,000 00
Northborough	818 66	1,578 57	227 60[1] 287 28	759 91	1,091 88	1,851 79	833 05
Northbridge	2,403 45	–	–	–	–	–	2,580 23
Northfield	695 64	–	–	–	–	–	701 42
Norton	829 38	1,294 13	22 50[1] 235 89	464 75	350 07	814 82	874 49
Norwell	536 57	1,455 35	1,422 33	918 78	811 00	1,729 78	572 35

[1] Lead sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Norwood	$5,000 00	–	–	–	–	–	$5,000 00
Oak Bluffs	1,049 83	$1,593 34	–	–	$1,361 71[2]	$936 71	1,148 78
Oakham	176 12	–	–	–	–	–	177 40
Orange	1,847 72	–	–	–	–	–	2,097 87
Orleans	656 77	646 50	$507 29	–	518 76	508 49	661 10
Oxford	977 12	–	–	–	–	–	983 59
Palmer	3,873 48	–	–	–	–	–	4,186 32
Paxton	195 45	–	–	–	–	–	194 55
Peabody	5,000 00	–	–	–	–	–	5,000 00
Pelham	220 12	–	–	–	–	–	220 49
Pembroke	579 63	1,862 16	71 70[1] 1,712 50	$1,282 93	912 42	2,195 35	617 66
Pepperell	1,089 29	2,164 95	117 70[1] 453 69	1,075 66	789 74	1,865 40	1,222 05
Petersham	554 23	–	–	–	–	–	555 29
Phillipston	139 40	–	–	–	–	–	149 91
Plainville	478 75	792 80	390 67	14 05	1,143 76[2]	857 81	511 08
Plymouth	5,000 00	–	–	–	–	–	5,000 00
Plympton	228 27	1,027 99	38 00[1] 205 45	799 72	400 60	1,200 32	235 25
Prescott	110 03	–	–	–	–	–	116 80
Princeton	447 53	2,016 19	34 00[1] 62 25	1,568 66	241 77	1,810 43	476 47
Provincetown	1,525 04	–	–	–	–	–	1,551 52
Quincy	5,000 00	–	–	–	–	–	5,000 00
Randolph	1,213 68	–	–	–	264 79	–	1,241 24
Raynham	546 64	532 89	444 00	–	68 03	54 28	557 40
Reading	3,686 12	–	–	–	–	–	3,805 54
Rehoboth	699 15	–	–	–	–	–	698 95
Revere	5,000 00	–	–	–	–	–	5,000 00
Rochester	469 17	530 73	276 69	61 56	326 55	388 11	444 03
Rockland	2,652 94	–	–	–	–	–	2,648 43
Rockport	1,818 11	–	–	–	–	–	1,868 23
Rowe	–	–	–	–	–	–	114 18
Rowley	439 21	1,178 81	487 00[1] 662 66	739 60	1,066 15	1,805 75	451 83
Royalston	401 07	–	–	–	–	–	412 92

[1] Lead sold.

[2] Includes sprayer, for which town paid one-half.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Rutland	$430 08	–	–	–	–	–	$440 67
Salem	5,000 00	–	–	–	–	–	5,000 00
Salisbury	933 88	$798 31	$89 92[1] 1,066 48	–	$732 01	$596 44	995 13
Sandwich	636 93	1,436 45	216 61[1] 870 70	$799 52	777 09	1,576 61	662 36
Saugus	3,385 72	–	–	–	–	–	3,548 00
Scituate	2,923 87	–	–	–	–	–	3,039 26
Seekonk	1,019 04	–	–	–	–	–	1,042 02
Sharon	1,531 69	1,478 33	543 74	–	783 25	729 97	1,588 16
Shelburne	936 36	–	–	–	–	–	937 24
Sherborn	704 35	2,242 31	20 80[1] 1,281 75	1,537 96	1,319 10	2,857 06	716 92
Shirley	785 83	791 75	490 95	–	466 58	466 58	792 76
Shrewsbury	1,839 37	1,673 83	490 21[1] 554 35	–	478 49	312 95	1,953 40
Shutesbury	157 87	–	–	–	–	–	149 21
Somerset	1,154 47	–	–	–	–	–	1,201 16
Somerville	5,000 00	–	–	–	–	–	5,000 00
South Hadley	2,206 78	–	–	–	–	–	2,167 97
Southborough	953 14	1,701 06	31 14[1] 918 88	747 92	784 08	1,532 00	1,117 95
Southbridge	4,468 90	–	–	–	–	–	4,538 16
Southwick	–	–	–	–	–	–	464 04
Spencer	1,524 52	–	–	–	–	–	1,568 06
Springfield	5,000 00	–	–	–	–	–	5,000 00
Sterling	596 82	848 27	129 82[1] 145 35	251 45	489 46	740 91	602 35
Stockbridge	2,298 32	–	–	–	–	–	2,316 45
Stoneham	2,960 59	–	–	–	–	–	3,100 15
Stoughton	2,346 88	–	–	–	–	–	2,377 63
Stow	632 89	816 51	567 51[1] 456 70	142 33	1,197 07	1,339 40	637 06
Sturbridge	438 90	–	–	–	–	–	489 45
Sudbury	603 44	988 75	355 36[1] 704 07	385 31	1,103 83	1,489 14	652 16
Sunderland	368 44	–	–	–	–	–	365 43
Sutton	677 30	–	–	–	–	–	715 09
Swampscott	5,000 00	–	–	–	–	–	5,000 00
Swansea	846 63	–	–	–	–	–	851 21

[1] Lead sold.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Continued.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Taunton	$5,000 00	–	–	–	–	–	$5,000 00
Templeton	1,038 80	$641 27	$373 88	–	$9 76	–	1,087 34
Tewksbury	1,156 15	2,448 14	810 91	$1,291 99	1,378 40	$2,670 39	1,172 96
Tisbury	971 27	1,486 89	74 00	90 62	1,952 20[2]	1,617 82	1,013 93
Topsfield	944 94	1,344 03	553 60	399 09	336 59	735 68	1,000 34
Townsend	828 04	1,324 39	538 32	496 35	723 73	1,220 08	838 64
Truro	260 26	448 01	99 00	187 75	253 98	441 73	256 23
Tyngsborough	377 27	2,176 67	1,360 43	1,799 40	1,390 76	3,190 16	394 96
Upton	593 18	–	–	–	–	–	582 29
Uxbridge	2,497 94	–	–	–	–	–	2,618 16
Wakefield	5,000 00	–	–	–	–	–	5,000 00
Wales	145 14	–	–	–	–	–	144 18
Walpole	3,243 93	–	–	–	–	–	3,416 67
Waltham	5,000 00	–	–	–	–	–	5,000 00
Ware	2,638 46	–	–	–	–	–	2,698 07
Wareham	3,298 73	–	–	–	–	–	3,357 26
Warren	1,530 20	–	–	–	–	–	1,614 71
Warwick	188 82	–	–	–	–	–	206 78
Watertown	5,000 00	–	–	–	–	–	5,000 00
Wayland	1,207 28	960 69	1,088 22	–	1,106 62	860 03	1,640 05
Webster	4,147 65	–	–	–	–	–	3,788 13
Wellesley	5,000 00	–	–	–	–	–	5,000 00
Wellfleet	351 88	690 58	10 64[1] 241 00	338 70	407 70	746 40	372 77
Wendell	266 69	–	–	–	–	–	295 38
Wenham	1,083 36	1,053 36	367 16	–	449 49	419 49	1,096 64
West Boylston	512 68	932 10	74 30[1] 573 20	419 42	518 57	937 99	524 12
West Bridgewater	833 36	2,013 10	89 40[1] 550 39	1,179 74	870 97	2,050 71	877 56
West Brookfield	461 13	–	–	–	–	–	454 94
West Newbury	434 48	844 50	39 00[1] 922 97	350 02	746 63	1,096 65	437 40
West Springfield	5,000 00	–	–	–	–	–	5,000 00
West Tisbury	240 07	–	–	–	–	–	250 21
Westborough	1,485 20	2,406 47	48 32[1] 681 76	921 27	766 65	1,687 92	1,516 63

[1] Lead sold.

[2] Includes sprayer, for which town paid one-half.

TABLE SHOWING EXPENDITURES AND REIMBURSEMENTS OF TOWNS AND CITIES FOR THE YEAR 1921 — *Concluded.*

CITIES AND TOWNS.	1921.						1922.
	Required Expenditure.	Total Net Expenditure.	Private Work.	Reimbursement.	Tools supplied.	Total Amount received from State.	Required Expenditure.
Westford	$1,099 63	$948 08	$451 90[1] 552 02	–	$1,406 75	$1,257 20	$1,234 46
Westhampton	–	–	–	–	–	–	131 53
Westminster	462 83	774 35	283 38	$311 52	395 12	706 64	466 42
Weston	2,164 52	4,465 01	417 50	–	2,092 52	2,092 52	2,328 94
Westport	1,855 17	–	–	–	–	–	1,846 88
Westwood	1,105 05	–	–	–	–	–	1,131 68
Weymouth	5,000 00	–	–	–	–	–	5,000 00
Whitman	2,505 83	–	–	–	–	–	2,545 15
Wilbraham	848 25	–	–	–	–	–	859 13
Wilmington	977 02	2,900 75	766 50	1,923 73	1,374 09	3,297 82	1,007 97
Winchendon	1,954 55	–	–	–	–	–	2,020 58
Winchester	5,000 00	–	–	–	–	–	5,000 00
Winthrop	5,000 00	–	–	–	–	–	5,000 00
Woburn	5,000 00	–	–	–	–	–	5,000 00
Worcester	5,000 00	–	–	–	–	–	5,000 00
Wrentham	763 52	–	–	–	–	–	819 98
Yarmouth	810 58	1,112 18	627 95	301 60	719 66	1,021 26	871 80

[1] Lead sold.

The Distribution of Supplies.

Supplies, including arsenate of lead and hose, have been furnished to towns and cities doing gypsy-moth work as usual. The amounts given in the list below do not always correspond exactly with the aid given the towns, as some towns make payments to the State for all or a part of the bill for supplies, according to the amount of their net expenditure or their class, under the provisions of section 4, chapter 132 of the General Laws.

For amounts received from this office in reimbursement and for expenditures, see table on page 61.

List of Cities and Towns and Amounts of Supplies furnished for 1921.

Abington	$1 50	Hanson	$694 82
Acton	1,101 16	Harvard	1,436 42
Ashburnham	177 60	Harwich	1,197 12
Ashby	608 75	Holbrook	121 91
Ashland	191 18	Holden	495 20
Avon	188 30	Holliston	494 02
Ayer	42 04	Hopkinton	389 07
Bedford	1,089 46	Ipswich	72 51
Berkley	109 80	Kingston	236 76
Berlin	363 02	Lakeville	547 62
Bolton	1,247 80	Lincoln	2,001 44
Boxborough	637 33	Littleton	1,010 75
Boxford	753 80	Lunenburg	1,038 13
Boylston	432 86	Lynnfield	1,100 86
Brewster	320 79	Marion	1,453 13
Bridgewater	1,223 68	Marshfield	1,787 15
Burlington	698 44	Mashpee	420 86
Carlisle	747 82	Medfield	827 49
Carver	2,403 00	Merrimac	409 73
Chatham	11 96	Middleborough	963 47
Chelmsford	109 72	Middleton	424 86
Dennis	531 38	Millis	17 00
Dover	1,054 85	Newbury	1,253 87
Dracut	1,259 05	Norfolk	551 17
Dunstable	213 69	North Reading	1,127 73
Duxbury	1,299 95	Northborough	1,091 88
East Bridgewater	999 71	Norton	350 07
Eastham	128 52	Norwell	811 00
Easton	1,824 74	Oak Bluffs	1,361 71
Essex	307 51	Orleans	518 76
Foxborough	857 98	Pembroke	912 42
Freetown	376 42	Pepperell	789 74
Georgetown	1,149 87	Plainville	1,143 76
Groton	862 66	Plympton	400 60
Groveland	424 13	Princeton	241 77
Halifax	476 23	Randolph	264 79
Hamilton	12 95	Raynham	68 03
Hanover	1,522 14	Rochester	326 55

LIST OF CITIES AND TOWNS AND AMOUNTS OF SUPPLIES FURNISHED FOR 1921 — *Concluded.*

Rowley	$1,066 15	Truro	$253 98
Salisbury	732 01	Tyngsborough	1,390 76
Sandwich	777 09	Wayland	1,106 62
Sharon	783 25	Wellfleet	407 70
Sherborn	1,319 10	Wenham	449 49
Shirley	466 58	West Boylston	518 57
Shrewsbury	478 49	West Bridgewater	870 97
Southborough	784 08	West Newbury	746 63
Sterling	489 46	Westborough	766 65
Stow	1,197 07	Westford	1,408 75
Sudbury	1,103 83	Westminster	395 12
Templeton	9 76	Weston	2,092 52
Tewksbury	1,378 40	Wilmington	1,374 09
Tisbury	1,952 20	Yarmouth	719 66
Topsfield	336 59		
Townsend	723 73		$80,215 26

Automobile supplies	$1,053 92
General forestry and nurseries	215 38
Prevention of forest fires	135 37
Maintenance of forests	285 87
Maintenance of nurseries	27 35
Special North Shore fund	3,511 93
Purchase and development of State forests	244 80
Purchase and planting of forest lands	1 90
Maintenance of Standish Monument	5 25
Experimental work	12 60
Massachusetts Highway Division	845 25
Traveling sprayers and trucks	941 62
	$7,281 24

STATEMENT OF EXPENDITURES AND RECEIPTS ON STATE FORESTS FOR THE YEAR ENDING NOV. 30, 1921.

STATE FOREST.	EXPENSES.					RECEIPTS.
	Planting and Nursery.	General Upkeep, Fire Lines, Roads, etc.	Surveying, etc.	Land.	Total.	
Arthur Warton Swann	$619 00	$649 54	$318 25	–	$1,586 79	$4,873 44
Bear Mountain	–	–	1,505 25	$23,283 00	24,788 25	–
Colrain	3,600 00	444 63	232 50	1,474 00	5,751 13	–
Conway	1,120 11	334 69	164 48	330 00	1,949 28	–
Erving	319 63	1,275 15	994 66	3,057 60	5,647 04	–
Harold Parker	287 35	–	231 00	–	518 35	25 00
Mohawk Trail	–	–	3,405 83	50,625 00	54,030 83	20 12
Mount Grace	–	655 99	1,054 36	22,400 00	24,110 35	–
Myles Standish	3,075 80	8,783 41	179 60	–	12,038 81	256 00
Otter River	2,343 98	2,050 14	–	–	4,394 12	20 00
Sandwich	–	–	493 50	952 69	1,446 19	275 00
Savoy Mountain	980 49	670 45	2,730 67	5,533 50	9,915 11	–
Tolland	1,441 06	1,363 65	2,080 47	1,280 00	6,165 18	–
Wendell	–	577 14	1,991 66	9,811 95	12,380 75	–
Totals	$13,787 42	$16,804 79	$15,382 23	$118,747 74	$164,722 18	$5,469 56

List of Forest Wardens and Local Moth Superintendents.

[Alphabetically by towns and cities.]

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3	John H. McMackins	Abington	C. F. Shaw	5
1	Wm. H. Kingsley	Acton	Albert H. Perkins	2
2	Saul Guibeault	Acushnet	Thos. Rogerson	4
5	Edgar A. Deyette	Adams	Edgar A. Deyette	6
5	Edw. M. Hitchcock	Agawam	E. M. Hitchcock	6
5	Wm. F. Milligan	Alford	- -	-
1	James E. Feltham	Amesbury	Joseph Merrill	3
4	A. F. Bardwell	Amherst	W. H. Smith	6
1	Lester Hilton	Andover	Edw. H. Berry	3
1	Walter H. Pierce	Arlington	Daniel M. Daley	2
6	C. H. Billings	Ashburnham	Chas. H. Pratt	2
6	W. S. Green	Ashby	Carl H. Houghton	2
6	Ralph Tredick	Ashfield	- -	-
1	Fred E. Johnson	Ashland	Theodore P. Hall	2
6	Frank P. Hall	Athol	George A. Whitney	6
2	Hiram R. Packard	Attleboro	W. E. S. Smith	4
4	J. F. Searles	Auburn	J. F. Searles	6
2	Stephen C. Graham	Avon	W. W. Beals	4
1	Dewey P. Downing	Ayer	John E. Keegan	2
3	Zebina H. Jenkins	Barnstable	Robert Cross	5
4	Albert E. Traver	Barre	Jas. A. Dwinnell	6
5	P. B. McCormack	Becket	- -	-
1	Irving C. Waite	Bedford	W. A. Cutler	3
4	John J. Fairchild	Belchertown	E. C. Howard	6
2	L. F. Thayer	Bellingham	Lewis E. Whitney	4
1	John F. Leonard	Belmont	Martin Troy	2
2	Gideon H. Babbitt	Berkley	A. A. Briggs	4
4	Forrest E. Day	Berlin	Albert R. Jones	2
6	Therman H. Keet	Bernardston	Edwin B. Hale	6
1	Robert H. Grant	Beverly	Jas. W. Blackmer	1
1	E. N. Bartlett	Billerica	Francis J. Dolan	3
4	John H. Dwyer	Blackstone	A. J. Duggan	6
5	I. E. Whitney	Blandford	- -	-
4	Harry L. Sutton	Bolton	C. E. Mace	2
- -	- -	Boston	Wm. P. Long	1
3	Walter E. R. Nye	Bourne	Edw. D. Nickerson	5

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
1	H. J. Livermore	Boxborough	S. D. Salmon, 3d	2
1	C. E. Brown	Boxford	Charles Perley	3
4	John N. Flagg	Boylston	Walter A. Stone	6
2	Fred Tenney	Braintree	Wm. J. McCusker	4
3	Thomas B. Tubman	Brewster	Abbott N. Baker	5
3	F. C. Worthen	Bridgewater	F. C. Worthen	5
4	Geo. E. Hitchcock	Brimfield	Frank G. Hitchcock	6
3	Wm. F. Daley	Brockton	Rufus H. Carr	5
4	Merrill A. Love	Brookfield	Albert Hobbs	6
2	Geo. H. Johnson	Brookline	Ernest B. Dane	1
6	Gilbert E. Griswold	Buckland	– –	–
1	Walter W. Skelton	Burlington	Walter W. Skelton	3
– –	– –	Cambridge	J. F. Donnelly	2
2	Edw. F. Healy	Canton	Wm. H. Gallivan	4
1	Geo. G. Wilkins	Carlisle	Geo. G. Wilkins	3
3	James S. McKay	Carver	James S. McKay	5
6	Albert L. Veber	Charlemont	– –	–
4	Marcus W. Carpenter	Charlton	Thos. Ashworth	6
3	Geo. W. Ryder	Chatham	Mervyn R. Martin	5
1	Herbert M. Sturtevant	Chelmsford	Chas. R. Forsythe	3
– –	– –	Chelsea	J. A. O'Brien	1
5	Daniel L. Wood	Cheshire	– –	–
5	Wm. H. Babb	Chester	– –	–
5	Wm. H. Baker, Jr.	Chesterfield	– –	–
4	Frank J. Thetreault	Chicopee	Edw. Bourbeau	6
3	Robert W. Vincent	Chilmark	Almon S. Tilton	5
5	A. G. Caswell	Clarksburg	A. G. Caswell	6
4	Andrew J. Robinson	Clinton	Peter R. Gibbons	2
2	Wm. J. Brennock	Cohasset	Joseph E. Grassie	5
6	F. A. Walden	Colrain	E. F. Copeland	6
1	Harry E. Tuttle	Concord	H. P. Richardson	2
6	Edgar Jones	Conway	– –	–
5	Wm. H. Mansell	Cummington	– –	–
5	John M. Caesar	Dalton	– –	–
4	Leroy H. Thayer	Dana	Thos. L. Thayer	6
1	Michael H. Barry	Danvers	T. E. Tinsley	1
2	C. H. Brownell	Dartmouth	E. M. Munson	4

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
2	Henry J. Harrigan	Dedham	J. T. Kennedy	4
6	Wm. L. Harris	Deerfield	Wm. L. Harris	6
3	Chas. E. Pierce[1]	Dennis	Joseph R. Hefen	5
2	Ralph Earl	Dighton	Albert N. Goff	4
4	Wm. L. Church	Douglas	F. J. Libby	6
2	Richard T. Breagy	Dover	H. L. MacKenzie	4
1	Frank H. Gunther	Dracut	T. F. Carrick	3
4	Gilbert Gion	Dudley	Herbert J. Hill	6
1	Archie W. Swallow	Dunstable	W. H. Savill	2
3	H. E. Merry	Duxbury	John D. Morrison	5
3	Allan B. Shaw	East Bridgewater	Allan B. Shaw	5
4	Arthur LeDoux	East Brookfield	Milton A. Putnam	6
4	Herman W. King	E. Longmeadow	Herman W. King	6
3	Adin L. Gill	Eastham	Wm. B. Higgins	5
5	John M. Dineen	Easthampton	Chas. Kuhfuss	6
2	Daniel F. Lordan	Easton	R. W. Melendy	4
3	Manuel S. Roberts	Edgartown	John P. Fuller	5
5	Frank Bradford	Egremont	–	–
4	Clinton Powell	Enfield	H. C. Moore	6
6	Chas. H. Holmes	Erving	Chas. H. Holmes	6
1	Otis O. Story	Essex	Otis O. Story	1
–	–	Everett	Dana Hanson	2
2	H. T. Howard	Fairhaven	G. W. King	4
2	Wm. Stevenson	Fall River	Wm. Stevenson	4
3	Herbert H. Lawrence	Falmouth	W. W. Eldridge, Jr.	5
6	Guy A. Hubbard	Fitchburg	Guy A. Hubbard	2
5	H. B. Brown	Florida	–	–
2	Frank C. Carpenter	Foxborough	C. W. Parkhurst	4
1	B. P. Winch	Framingham	N. I. Bowditch	4
2	Ernest L. Metcalf	Franklin	J. W. Stobbart	4
2	Lyman B. Grinnell	Freetown	Lyman B. Grinnell	4
6	Geo. S. Hodgman	Gardner	Chas. J. Crabtree	6
3	Nelson A. Francis	Gay Head	Nelson A. Francis	5
1	Leslie P. Merrill	Georgetown	Jacob Hasen	3
6	Lewis C. Munn	Gill	Warren R. Purple	6
1	Harland W. Dann	Gloucester	Harland W. Dann	1
5	Frank L. Rice	Goshen	–	–

[1] Deceased.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3	Frederick A. Veeder	Gosnold	– –	–
4	Elmer E. Sibley	Grafton	C. K. Despeau	6
4	Chas. N. Rust	Granby	George A. Harris	6
5	A. C. Sheets	Granville	– –	–
5	Daniel W. Flynn	Great Barrington	Daniel W. Flynn	6
6	John W. Bragg	Greenfield	John W. Bragg	6
4	Wm. H. Walker	Greenwich	Thos. Severance, Jr.	6
1	A. A. Wood	Groton	Shadrach Evans	2
1	Geo. L. Nelson	Groveland	R. D. Larive	3
4	Edward P. West	Hadley	Leroy C. Savin	6
3	Geo. H. Armstrong	Halifax	John A. Wood	5
1	Fred Berry	Hamilton	Harry R. McGregor	1
4	John Swenson	Hampden	– –	–
5	Alfred Rathbun	Hancock	– –	–
3	Louis E. Stone	Hanover	Basil S. Simmons	5
3	Simeon Thompson	Hanson	Simeon Thompson	5
4	George J. Fay	Hardwick	George J. Fay	6
4	George C. Maynard	Harvard	George C. Maynard	2
3	John Condon	Harwich	Arthur F. Cahoon	5
5	Fred T. Bardwell	Hatfield	Seth W. Kingsley	6
1	John B. Gordon	Haverhill	M. J. Fitzgerald	3
6	Herbert A. Holden	Hawley	– –	–
6	S. G. Benson	Heath	– –	–
3	Wm. L. Howard	Hingham	T. L. Murphy	5
5	Alfred N. Warren	Hinsdale	– –	–
2	Melvin L. Coulter	Holbrook	Frederick W. Whitcomb.	4
4	Fred F. Taylor	Holden	Winfred H. Stearns	6
4	Arthur F. Blodgett	Holland	Arthur F. Blodgett	6
12	Walter A. Collins	Holliston	Herbert E. Jones	2
5	C. J. Haley	Holyoke	John F. Kennedy	6
4	S. E. Kellogg	Hopedale	C. E. Nutting	6
1	George W. Smith	Hopkinton	W. A. Macmillan	6
4	Wm. F. Noone	Hubbardston	Chas. P. Wyman	6
1	M. P. Mitchell	Hudson	T. J. Higgins	2
– –	– –	Hull	John F. Smith	5
5	John Kirby	Huntington	– –	–
1	Thomas R. Roberts	Ipswich	Francis C. Wade	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3	Roland Bailey	Kingston	Chas. H. Childs	5
3	Nathan F. Washburn	Lakeville	Leavitt C. Caswell	5
4	Arthur W. Blood	Lancaster	L. R. Griswold	2
5	King D. Keeler	Lanesborough	– –	–
1	Francis J. Morris	Lawrence	Edward Flynn	3
5	James W. Bossidy	Lee	– –	–
4	John E. Fitzpatrick	Leicester	J. H. Woodhead	6
5	O. R. Hutchinson	Lenox	Wheeler A. Shepardson.	6
6	Frederick A. Russell	Leominster	D. E. Bassett	2
6	Fred Morrison	Leverett	I. H. Taylor	6
1	Osborne J. Gorman	Lexington	Osborne J. Gorman	3
6	A. G. Parks	Leyden	A. G. Parks	6
1	John J. Kelliher	Lincoln	John J. Kelliher	2
1	A. E. Hopkins	Littleton	A. E. Hopkins	2
4	Oscar C. Pomeroy	Longmeadow	– –	–
1	Edw. F. Saunders	Lowell	J. G. Gordon	3
4	Henry A. Munsing	Ludlow	Ashley M. Bucher	6
6	Arthur Q. Emerson	Lunenburg	Arthur Q. Emerson	2
1	John P. Morrissey	Lynn	John P. Morrissey	1
1	F. C. Newhall	Lynnfield	L. H. Twiss	1
1	Watson B. Gould	Malden	Watson B. Gould	2
1	Peter A. Sheahan	Manchester	Peter A. Sheahan	1
2	H. E. King	Mansfield	E. H. Conant	4
1	Wm. H. Atkins	Marblehead	W. H. Stevens	1
3	Arthur J. Morse	Marion	J. Allenach	5
1	Edward C. Minehan	Marlborough	M. E. Lyons	2
3	Wm. G. Ford	Marshfield	P. R. Livermore	5
3	Darius Coombs	Mashpee	S. H. Peters	5
3	Chas. T. Dexter	Mattapoisett	John S. Hammond	5
1	Geo. H. Gutteredge	Maynard	John F. Cleary	2
2	Allen Kingsbury	Medfield	G. L. L. Allen	4
1	Thomas Qualey	Medford	Hugh G. Kennedy	2
2	John B. Durfee	Medway	Cecil W. Lawrence	4
– –	– –	Melrose	J. J. McCullough	3
4	Carl M. Taft	Mendon	F. M. Aldrich	6
1	Chas. R. Ford	Merrimac	Chas. R. Ford	3
1	Thomas Dow	Methuen	A. H. Wagland	3

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3	Harry J. Goodale	Middleborough	John J. Fowler, Jr.	5
5	George E. Cook	Middlefield	– –	–
1	J. Allen Atwood	Middleton	Burton McGlauflin	1
4	Edward J. Burke	Milford	P. F. Fitzgerald	6
4	Harry L. Snelling	Millbury	E. F. Rosch	6
2	Chas. LaCroix	Millis	Everett L. Coldwell	4
4	Robert McLaughlin	Millville	Patrick Britt, Sr.	6
2	J. Harry Holmes	Milton	Ralph E. Forbes	4
6	E. C. Davis	Monroe	– –	–
4	O. E. Bradway	Monson	Robert S. Fay	6
6	Myron A. Wakefield	Montague	F. B. Gillette	6
5	Jasper H. Bills	Monterey	– –	–
5	A. J. Hall	Montgomery	– –	–
5	Howard Porter	Mount Washington.	– –	–
– –	– –	Nahant	Herbert Coles	1
3	E. W. Francis	Nantucket	W. M. Voorneveld	5
1	John H. Neary	Natick	Jesse E. Wight	2
2	H. Howard Upham	Needham	George Twigg	4
5	Chas. S. Baker	New Ashford	– –	–
3	Edward F. Dahill	New Bedford	C. F. Lawton	4
4	Frank A. Morse	New Braintree	E. L. Havens	6
5	Edw. M. Stanton	New Marlborough.	– –	–
6	Edwin A. Goodnow	New Salem	Frank Hamilton	6
1	Wm. P. Bailey	Newbury	Percy Oliver	3
1	Chas. P. Kelley	Newburyport	Chas. P. Kelley	3
1	Walter B. Randlett	Newton	Chas. Benyon	2
3	Stephen C. Watson	Norfolk	J. Albert Buckley	4
5	H. J. Montgomery	North Adams	Jackson L. Temple	6
1	Wm. L. Smith	North Andover	Wm. L. Smith	3
2	H. W. Tufts	North Attleborough.	F. P. Toner	4
4	Oscar C. Hirbour	North Brookfield	S. B. Colburn	6
1	George H. Spear	North Reading	George E. Eaton	3
5	John H. Marlow	Northampton	Chas. A. Maynard	6
4	Frank Gates	Northborough	T. P. Haskell	6
4	Daniel C. Duggan	Northbridge	A. F. Whitin	6
6	Fred W. Doane	Northfield	Fred W. Doane	6
2	George H. Storer	Norton	Albert S. Lincoln	4

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
3	Arthur Coombs	Norwell	Fred M. Curtis	5
2	Frank W. Talbot	Norwood	Wm. P. Hammersley	4
3	George A. Smith	Oak Bluffs	F. F. Blankenship	5
4	C. H. Trowbridge	Oakham	C. H. Trowbridge	6
6	Wm. Walsh	Orange	Elbridge S. Blodgett	6
3	James Boland	Orleans	Albert A. Smith	5
5	Wesley Deming	Otis	– –	–
4	Arthur Allen	Oxford	Eugene Wetherell	6
4	James Summers	Palmer	Arthur F. Bennett	6
4	Henry H. Pike	Paxton	H. S. Robinson	6
1	John J. Callahan	Peabody	John J. Callahan	1
4	Austin L. Kimball	Pelham	Leigh Weaver	6
3	J. J. Shepherd	Pembroke	Wm. C. Jones	5
1	Grant M. Palmer	Pepperell	John Tune	2
5	Walter H. Pike	Peru	– –	–
4	George Marsh	Petersham	Daniel Broderick	6
6	Wm. H. Cowlbeck	Phillipston	Wm. H. Cowlbeck	6
5	Chas. L. Klein	Pittsfield	– –	–
5	E. H. Nye	Plainfield	– –	–
2	Frank V. Herrick	Plainville	George H. Snell	4
3	Ira C. Ward	Plymouth	A. A. Raymond	5
3	David L. Bricknell	Plympton	David L. Bricknell	5
4	Fred W. Doubleday	Prescott	Harrison D. Pierce	6
4	Fred W. Bryant	Princeton	F. A. Skinner	6
3	James H. Barnett	Provincetown	F. G. Hill	5
2	Alfred L. Mead	Quincy	A. J. Stewart	4
2	Fred Dianto	Randolph	John F. Moore	4
2	James C. Williams	Raynham	James C. Williams	4
1	Orville O. Ordway	Reading	H. M. Donegan	3
2	B. F. Munroe	Rehoboth	Chas. B. Douglas	4
– –	– –	Revere	Walter A. Sancrie	1
5	Timothy B. Salmon	Richmond	– –	–
3	Daniel E. Hartley	Rochester	Maxwell Gifford	5
3	John H. Burke	Rockland	F. H. Shaw	5
1	John C. Martin	Rockport	F. A. Babcock	1
6	Merritt A. Peck	Rowe	– –	–
1	Daniel O'Brien	Rowley	Chas. Curtis	3

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
6	M. E. Stockwell	Royalston	E. S. Stewart	6
5	Wm. C. Chadwick	Russell	–	–
4	H. Edw. Wheeler	Rutland	H. Edw. Wheeler	6
–	–	Salem	Oliver G. Pratt	1
1	Chas. J. Penniman	Salisbury	Chas. J. Penniman	3
5	Chas. D. Strickland	Sandisfield	–	–
3	J. R. Holway	Sandwich	Lincoln Crowell	5
1	Harry Saxon	Saugus	T. E. Berrett	1
5	C. E. Tilton	Savoy	–	–
3	C. M. Litchfield	Scituate	Wm. F. Ford	5
2	H. S. Baker	Seekonk	C. A. Smith	4
2	W. C. Morse	Sharon	Fred A. White	4
5	R. M. Smith	Sheffield	–	–
6	Chas. S. Dole	Shelburne	Chas. S. Dole	6
1	Fred J. Dingley	Sherborn	Geo. W. Rock	2
1	Asa A. Adams	Shirley	Asa A. Adams	2
4	Edw. A. Logan	Shrewsbury	Robt. C. Clapp	6
6	C. N. Mellen	Shutesbury	E. C. Johnson	6
2	F. B. Butterwort	Somerset	Chas. Riley	4
–	–	Somerville	A. B. Prichard	2
4	E. M. Shumway	South Hadley	E. M. Shumway	6
5	W. J. Lyman	Southampton	–	–
4	Eugene Closson	Southborough	Harry Burnett	6
4	Aimee Langevin	Southbridge	Aimee Langevin	6
5	B. M. Hastings	Southwick	–	–
4	E. J. Potter	Spencer	Geo. Ramer	6
4	Frank C. Smith	Springfield	L. Fletcher Prouty	6
4	Joel T. Wilder	Sterling	J. H. Kilburn	2
5	George Schneyer	Stockbridge	George Schneyer	6
1	Albert J. Smith	Stoneham	G. M. Jefts	3
2	Fred H. Pye	Stoughton	W. P. Kennedy	4
1	Harold A. Priest	Stow	H. W. Herrick	2
4	C. M. Clarke	Sturbridge	C. M. Clarke	6
1	Seneca W. Hall	Sudbury	Chas. A. Brackett	2
6	A. C. Warner	Sunderland	Richard Graves	6
4	R. H. Richardson	Sutton	R. H. Richardson	6
1	Everett P. Mudge	Swampscott	Everett P. Mudge	1

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
2	Arthur E. Arnold	Swansea	Arthur E. Arnold	4
2	Fred A. Leonard	Taunton	H. M. Briggs	4
6	C. A. Fletcher	Templeton	J. B. Wheeler	6
1	Alden S. Haines	Tewksbury	H. M. Briggs	3
3	Lester H. Bumpus	Tisbury	H. W. McLellan	5
5	Rupert E. Clark	Tolland	– –	–
1	Wayland E. Burnham	Topsfield	Wayland E. Burnham	1
6	Frederick J. Piper	Townsend	Wm. W. Copeland	2
3	Walter F. Rich	Truro	J. H. Atwood	5
1	C. J. Allgrove	Tyngsborough	C. J. Allgrove	3
5	George R. Warner	Tyringham	– –	–
4	H. E. Allard	Upton	Clarence L. Goodrich	6
4	Thomas F. Casey	Uxbridge	Frank J. O'Brien	6
1	Fred D. Graham	Wakefield	John A. Landrey	3
4	L. H. Thompson	Wales	M. C. Royce	6
2	Chester L. Donnell	Walpole	Elton F. Durfee	4
1	George L. Johnson	Waltham	W. M. Ryan	2
4	Alfred H. Pigeon	Ware	F. Zeissig	6
3	James J. Walsh	Wareham	James J. Walsh	5
4	T. M. Collins	Warren	Nathan H. Powers	6
6	C. A. Williams	Warwick	Chas. Bass	6
5	A. L. Hayes	Washington	– –	–
1	John W. O'Hearn	Watertown	Van D. Horton	2
1	Howard C. Haynes	Wayland	D. J. Graham	2
4	John C. Templeman	Webster	Clark C. Klebart	6
2	John P. Doyle	Wellesley	Thos. T. Watt	4
3	Frank Fisher	Wellfleet	Wm. H. Gill	5
6	Henry Champlin	Wendell	G. E. Mills	6
1	Jacob D. Barnes	Wenham	Jacob D. Barnes	1
4	Harry E. Lowe	West Boylston	Harry E. Lowe	6
3	W. P. Laughton	West Bridgewater	Christopher Read	5
4	John H. Webb	West Brookfield	John H. Webb	6
1	Edward Johnston	West Newbury	Frank D. Bailey	3
5	Walter L. Haines	West Springfield	George W. Hayden	6
5	Benj. P. Bissell	West Stockbridge	– –	–
3	Henry B. Davis	West Tisbury	Jerry B. Mayhew	5
4	Thos. W. Humphrey	Westborough	George E. Hayden	6

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

District Number.	Forest Warden.	Town or City.	Local Moth Superintendent.	Div. No.
5	T. H. Mahoney	Westfield	- -	-
1	H. L. Nesmith	Westford	H. L. Nesmith	3
5	Myron M. Clapp	Westhampton	- -	-
6	W. F. Neal	Westminster	G. A. Sargent	6
1	B. R. Parker	Weston	E. P. Ripley	2
2	Christopher Borden	Westport	Christopher Borden	4
2	Elmer E. Smith	Westwood	Martin Sorenson	4
2	Philip W. Wolfe	Weymouth	C. L. Merritt	4
6	J. J. Phinn	Whately	Rylan C. Howes	6
3	Clarence A. Randall	Whitman	Clarence A. Randall	5
4	Henry I. Edson	Wilbraham	Henry I. Edson	6
5	Arthur J. Polmatier	Williamsburg	- -	-
5	Armedee Remillard	Williamstown	Daniel J. Connor	6
1	E. L. Day	Wilmington	Oliver McGrane	3
6	Theron C. Flint	Winchendon	Waldo F. Streeter	6
1	David H. DeCourcy	Winchester	S. S. Symmes	3
5	Amos S. Ferry	Windsor	- -	-
- -	- -	Winthrop	Harry Hills	1
1	Frank E. Tracy	Woburn	Wm. Butler Jones	3
4	Edw. L. Janes	Worcester	Thos. E. Holland	6
5	Chas. A. Kilbourn	Worthington	- -	-
2	Geo. H. E. Mayshaw	Wrentham	Ernest B. Mayshaw	4
3	Henry R. Usher	Yarmouth	Frank B. Homer	5

HARVARD FOREST

BULLETIN NO. 2

RICHARD T. FISHER, *Director*

Growth Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England

BY

J. NELSON SPAETH

HARVARD FOREST, PETERSHAM, MASS.

1920

COPYRIGHT, 1920
HARVARD UNIVERSITY PRESS

CONTENTS

Summary of Conclusions 4
Introduction 5
The Region 6
The Forest 8
Collection of Data 10
Construction of Yield Tables 10
Discussion of Table II 12
Table II. Yield of Better Hardwoods in Cubic Feet and Cords . 13
Discussion of Table III 16
Table III. Yield of Better Hardwoods in Board Feet 17
Discussion of Table IV. 18
Table IV. Yield of Inferior Hardwoods 19
Applicability of Tables 20
Botanical Names of Species Mentioned 21

SUMMARY OF CONCLUSIONS

FOR even-aged second growth hardwood stands in Central New England this study leads to the following conclusions:

I. After cutting the mixed hardwood type regenerates itself substantially unchanged and generally follows the logging of pine stands. The type is, therefore, greatly on the increase in the region.

II. At seventy years on the better sites fully stocked stands produce twenty thousand and on the poorer thirteen thousand board feet of saw timber.

III. In spite of wide variation in percentages of species in mixture, for a given age, site, and density the volume in board feet, cubic feet, and cords is constant.

IV. The volume of a tree of given height and diameter in cords and cubic feet is the same regardless of species.

GROWTH STUDY AND NORMAL YIELD TABLES FOR SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

INTRODUCTION

THE present growth study and accompanying yield tables relate to forest types which, though of great and ever increasing importance in the economic life of Central New England, have thus far received but little attention. Situated in the transition belt between the northern hardwood forests of New Hampshire and Vermont and the "sprout" hardwood forests of Connecticut, they combine characteristics of each.

The numerous woodworking industries of the smaller towns and cities furnish a ready outlet for all classes of timber and the use of hardwood in the region, already varied, is rapidly increasing. At present the local hardwood supply is by no means sufficient to satisfy the demand, but hardwood acreage is on the increase due to the tendency of pine lots when cut to reproduce to hardwood. Through simple silvicultural operations, such as have been developed on the Harvard Forest,[1] future stands of this type can be greatly improved as to percent of the more valuable species in mixture, density of stocking and form of trees. The cost of such operations has been shown to be thoroughly justified by the increased value of stands so handled. Since the accompanying tables are based on the actual volumes of fully-stocked, natural stands they represent the minimum to be expected under forest management.

[1] For full discussion of these operations see article by R. T. Fisher, "The Yield of Volunteer Second Growth as Affected by Improvement Cutting and Early Weeding." *Journal of Forestry*, vol. 16, May 1918.

THE REGION

Owing to the range in elevation and variety of soils it is difficult to give accurate geographic boundaries for the region to which this study is applicable. In general, second growth hardwood stands of the types studied occur over central and western Massachusetts, southern Vermont and New Hampshire and northern Connecticut, "sprout" hardwoods extending north in the valleys and northern hardwoods south on the hills.

In north-central Massachusetts, where the field data were gathered, stands reach their optimum on moist benches and gentle slopes at low elevations. East of the Connecticut River valley bottoms average 650 feet in elevation above sea level and the elongated granite, syenite and gneissoid ridges 1150 feet in altitude, their long axes being roughly north and south. Escarpments from a few feet to a hundred or more in height are not uncommon. West of the Connecticut the topography becomes gradually more broken until in the Berkshires it is mountainous, with Greylock rising to the height of 3600 feet.

The soils are mostly glacial in origin, ranging from deep, fertile agricultural land with few boulders (but a small portion of the area is of this type except for the valley floors of the Connecticut and tributary streams) to very thin, bouldery deposits on the bed rock of the ridge-tops and steep slopes almost exclusively covered with huge, angular fragments. There is a distinct tendency toward sandy rather than clay loams with a great abundance of loose rock and boulders of all sizes. Considerable areas of sand plain are occasional. With the exception of the Connecticut River valley some seven-tenths of the area is absolute forest land, either because of its low fertility, steep slope, or abundance of large boulders.

FIGURE 2. Sapling White Ash, Red Oak, and Hard Maple Ten Years after Cutting a Previous Crop of Sixty-five Year Old White Pine. Stand Freed of Inferior Species by Two Weedings.

THE FOREST

The original forest, covering over ninety per cent of the area, was a transitional belt between the Northern and Central Hardwoods, in which sugar maple, beech, yellow birch, white and black ashes, paper birch, black cherry, basswood, poplar, elm, red maple, red spruce and red pine of the Northern Forest intermingled with chestnut, red, black, scarlet, chestnut and white oaks, black birch, hickory and tupelo. Isolated fragments of this forest still exist and seem to indicate that hemlocks and white pines were everywhere scattered through it, either as individuals or in small groups.

Seventy years ago at least half of the area now wooded was cleared land. The opening up of the West in conjunction with the Civil War caused the abandonment of the less productive farms a little over a half century ago. The present forest types are to a greater or lesser extent transitional, resulting from the human occupation of the land. Three types are important, better second growth hardwoods, inferior second growth hardwoods, and second growth pine. Of these the first most nearly approaches the climax type to which all others tend to revert, differing from it somewhat in the proportions of the various species in mixture and in being even-aged and partly of sprout rather than seedling origin.

The second growth pine type (from fifty to one hundred per cent white pine) follows directly the abandonment of land cleared for agriculture and may be succeeded by either of the hardwood types. If cut at the age of fifty years or more a stand of better second growth hardwood results from the advanced hardwood growth which, at that age, has become established under the pine stand. If cut at an age under fifty years an inferior second growth hardwood stand results, due to the lack of hardwood advanced growth and the subsequent reproduction by light seeded species. If left beyond maturity the hardwoods would probably gain a place in the dominant stand and there would result a climax forest of

uneven-aged better hardwoods of seedling origin in which there might be scattered pine and hemlock.

A better second growth hardwood stand (one in which the better timber trees such as red oak, white ash, sugar maple, yellow birch, etc., predominate) follows the clear cutting of a previous stand of similar composition and is largely of sprout origin or follows the cutting of a pine stand over fifty years of age and is largely of seedling and seedling-sprout origin. As shown by observations on the Harvard Forest, when a pine stand is cut in a seed year (*i. e.*, the autumn or winter following a heavy fall of seed) great numbers of pine seedlings (20,000 to 40,000 per acre) cover the area the following spring. Hardwood competition during the early life of the new stand is so strong, however, that it is only in rare instances that a second pine stand results, hardwood succeeding the cutting of pine almost without exception. The better second growth hardwood type is thus decidedly on the increase throughout the region and is growing rapidly in economic importance. Red oak and white ash are the most important species, replacing to a large extent the dying chestnut which, once of great commercial importance, will probably be eliminated from future stands by the chestnut blight (*Endothia parasitica*). Because it most nearly approaches the climax, this type is the easiest to maintain and will be the basis of future forest management on the better soils. Reproduction areas on the Harvard Forest show that under simple forest management red oak and white ash may make up as high as eighty per cent of the total stand. Table I (page 11) will serve to indicate the average composition of natural stands.

In inferior second growth hardwood stands gray birch, red maple and poplar predominate, the percentage of red maple being dependent upon the amount of soil moisture. This type originates on burns or where pine stands under fifty years of age are cut. If left beyond maturity (twenty-five to thirty years for gray birch) the birch disintegrates and

better hardwood seedlings creep in until a stand of the climax or better second growth hardwood type results. If cut before thirty years of age a second inferior stand of sprout origin follows the first.

COLLECTION OF DATA

The forty-eight sample plots, containing over 18,000 trees, upon which the accompanying yield tables are based were carefully selected over an area of 175 square miles in northern Worcester County, Massachusetts. Only fully stocked natural stands of even age were measured. The individual plots were either one-quarter or one-half acre in area, being strips one chain wide and two-and-one-half or five chains long. All trees two inches and over in diameter breast high were calipered and tallied in inch diameter classes by species and the merchantable logs recorded by diameter and species as in timber estimating. The heights of several trees in each crown class were taken and a partial forest description made upon the completion of the strip. Plots ranged from seventeen to seventy-five years of age, the older stands being difficult to find. Stands over seventy-five years of age were unobtainable due to the history of the region and the fact that timber is usually cut before it approaches that age.

CONSTRUCTION OF YIELD TABLES

Of the forty-eight sample plots gathered forty represent the type designated as better second growth hardwoods and eight the type designated as inferior second growth hardwoods. The better second growth hardwood plots were divided into site classes I and II on the basis of average height of the dominant trees. Table I gives the percentages of the various species in mixture on the sample plots, classified as to type and site class.

TABLE I. PERCENTAGE OF THE VARIOUS SPECIES IN MIXTURE, CLASSIFIED AS TO TYPE AND SITE CLASS

	Red Oak	Red Maple	Hard Maple	Gray Birch	Paper Birch	Yellow Birch	Beech	Chestnut	Bass-Wood	Poplar	White Ash	Miscell.[1]
Better Hwd.												
Qual. I	27	15	3	0	2	8	2	6	9	7	15	6
Qual. II	20	12	6	0	8	10	7	5	3	8	14	7
Inferior Hwd.	2	24	2	38	3	4	0	1	0	15	1	10

The question of handling chestnut as a species in the construction of the yield tables presented the greatest difficulty encountered, for while all indications are that future stands will contain no merchantable trees of this species it is important in the majority of the present stands. By careful selection of the plots the number of chestnut trees was reduced to six per cent or less, though they might make up as high as ten per cent of the volume. An examination of the tally sheets of all plots showed the chestnut to exceed the oak on the same plot by two diameter classes. That is, if the diameters of the oaks on a given plot ranged from five to nine inches with the average 7.2 inches, the diameters of the chestnuts on the same plot were found to range from 9–11 inches with the average at 9.2 inches. Moreover, measurements of projected crown areas showed that the crown of a 9.2 inch chestnut, due to difference in habit of the species, occupied approximately the same space in the dominant stand as the crown of a 7.2 inch oak. This was taken to indicate that where chestnut trees now occur, oaks two inches less in diameter may occur in future stands. That they will occur in many instances seems almost certain since oak is the most abundant species in present stands where the percent-

[1] Under miscellaneous are included all species whose representation in the plots of any one type or site class is less than five per cent of the total number of trees. These species are: — white oak, black cherry, pignut hickory, white pine, hemlock, elm, butternut, hop hornbeam, black birch, flowering dogwood and shad bush.

age of chestnut is low. As will appear later, even if species other than red oak take the place of chestnut the difference in volume production will not be greatly changed. By careful selection of plots error due to the presence of chestnut was reduced to a small percentage. By reducing the diameters of the few chestnuts on the plots by two diameter classes it was practically eliminated.

The red maple, which is a considerable element in all stands, produces good cordwood, but many trees are too poor in quality to yield saw timber. Species such as hornbeam, shad bush, dogwood, etc., were limited to the lower diameter and suppressed crown classes and were insignificant in volume production.

Table II gives the normal yield per acre in cords and cubic feet of fully stocked natural stands of second growth better hardwoods. All trees two inches and over in diameter breast high are included. But two site classes exist. The thin-soiled, bouldery ridge-tops of third quality, because of their low yield per acre and inaccessibility have never been clear cut, and on sandy soils, deficient in organic content and moisture, the competition of white pine and inferior hardwoods is such as to exclude the better hardwoods.

In discussing the construction of the tables the various columns will be taken up separately giving the methods used in obtaining yield table values and their application.

Basal Area. Omitted in the majority of American yield tables, basal area is always desirable and is essential unless both the number of trees per acre and the average diameter are given, in which case it may be computed. Basal area, not trees per acre, is the criterion of density of stocking on similar sites and is therefore indispensable. The percentage density of stocking of a given stand results from dividing the basal area of a representative acre of that stand by the normal basal area for the site as given in the yield table, site being determined by the average height of the dominant trees.

TABLE II. NORMAL YIELD PER ACRE IN CUBIC FEET AND CORDS OF BETTER SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

Site Class I

(All trees 2 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. feet	Height in feet	D.B.H. in inches	Volume per acre cubic feet	Volume per acre cords	Forest form factor
20	1250	66.0	27.1	3.11	1041	15.80	.582
25	1120	90.8	33.0	3.86	1625	23.71	.542
30	1010	107.2	37.5	4.41	2150	29.75	.501
35	900	119.9	41.5	4.94	2628	34.96	.503
40	800	130.2	45.0	5.46	3058	39.63	.520
45	700	139.7	48.2	6.05	3495	44.03	.520
50	610	148.0	50.7	6.69	3898	48.00	.520
55	525	155.7	53.1	7.37	4298	51.84	.520
60	450	162.5	55.4	8.14	4677	55.50	.520
65	390	169.0	57.8	8.91	5068	59.25	.520
70	340	175.1	59.8	9.72	5462	62.75	.522
75	300	180.9	61.9	10.51	5833	66.18	.521
80	270	186.3	64.0	11.25	6200	69.50	.520

Site Class II

(All trees 2 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. feet	Height in feet	D.B.H. in inches	Volume per acre cubic feet	Volume per acre cords	Forest form factor
25	1360	59.8	27.8	2.84	982	14.65	.593
30	1235	77.9	31.8	3.40	1380	20.40	.557
35	1125	91.1	34.8	3.86	1798	25.48	.567
40	1030	101.6	37.4	4.25	2180	29.53	.574
45	940	110.3	39.8	4.66	2534	33.04	.577
50	855	117.9	41.5	4.94	2828	35.98	.580
55	775	124.6	42.8	5.43	3118	38.55	.584
60	700	130.7	44.2	5.85	3375	41.08	.584
65	630	136.6	45.3	6.31	3638	43.42	.587
70	565	142.2	46.3	6.79	3895	45.61	.592
75	500	147.7	47.0	7.36	4146	47.75	.598
80	440	153.0	47.6	7.98	4390	49.80	.601

Diameter Breast High. The average, breast-high diameter of all trees over two inches was obtained by dividing the basal area per acre by the number of trees per acre. Two factors cause variation in the average diameters of trees in fully stocked stands of the same age. First, the normal basal area and crown cover may exist when the dominant stand contains few trees of large diameter and crown spread or many trees with small diameters and crowns: second, there may or may not be a large number of suppressed and intermediate trees in the stand. If there is the diameter of the average tree is greatly reduced.

Cubic Foot and Cord Volume per Acre. Several methods of obtaining volumes in the construction of yield tables are recognized. Perhaps the most common is that of the mean sample tree. This method involves the computation of the mean at the time of measuring the sample plots and the cutting and partial stem analysis of several sample trees for each plot. In the present case, a red maple volume table, made on the Harvard Forest,[1] and giving volumes in cubic feet and cords, was used. Its applicability was established by the following test. A quarter acre sample plot was carefully laid out in a twenty-eight year old better second growth hardwood stand on quality one site. Its approximate composition was red oak thirty per cent, red maple twenty-five per cent, chestnut fifteen per cent, yellow birch eight per cent and miscellaneous species twenty-two per cent. All trees over two inches were calipered and tallied in inch diameter classes and a number of heights taken. Three inch diameter classes were then formed and the height and diameter of the mean sample tree for each of these was determined. At least three mean sample trees for each class were then felled and cut into bolts four feet two inches long, the

[1] Original: A Volume Table For Red Maple on the Harvard Forest, E. E. Carter, Bulletin of the Harvard Forestry Club, vol. 2, 1913.

Revised: Volume Table for Red Maple on the Harvard Forest (Revised and Enlarged by E. E. Carter in 1915). U. S. D. A. Bull. 285, The Northern Hardwood Forest: Its Composition, Growth and Management, pp. 61–63.

middle and small end diameter of each bolt being recorded. The cubic foot volumes of the sample trees were then calculated by Newton's formula $(B+4b_{\frac{1}{2}}+b)\frac{h}{6}$. The cubic foot and cord volumes of the plots were calculated by the use of the volumes of the mean sample trees. The cubic foot and cord volumes were also computed by both the original and the revised red maple volume tables using the original tally of the plot to find the number of trees in each diameter class by which the volume of a single tree in that class, as found in the red maple table, was multiplied. The quarter-acre plot was then cut clear and piled as four-foot wood, the measurement of the piled wood giving the actual volume of the stand. Results of the test are given below.

Method	Yield per ¼ acre	Error
Actual volume cut	5.725 cords	
Revised volume table	5.772 "	.83 %
Original volume table	5.822 "	1.70 %
Mean sample tree method	5.935 "	3.84 %

This test shows not only that the use of the volume table was more accurate than even a very carefully executed sample tree method but also that with even-aged second growth stands it can be applied according to diameter breast high and height regardless of species. Cubic foot and cord volumes in the yield tables are derived by harmonizing with a curve the sums of the volumes of the individual trees on these plots as determined by the revised red maple volume table.

Forest Form Factor. A forest form factor is the ratio between the volume of a stand and that of a cylinder having the basal area of the stand and the height of the average tree. It is most easily expressed in cubic feet. Those here given are breast-high, merchantable, cubic foot forest form factors obtained by multiplying the basal area of the stand by the average height of the dominant trees and dividing the yield per acre in cubic feet, as given in the yield table, by the

resulting number. Such a form factor is admittedly an arbitrary ratio being dependent upon the basal area of all trees in the stand and the average height of the dominant trees only. Its use is simplified, however, in that the cubic foot volume of the stand may be calculated directly by the formula V = BHF in which V = volume of stand in cubic feet, B = breast-high basal area, H = average height of dominant tree and F = forest form factor, the average height of the dominant tree being less variable than the average height of all trees. It will be noted that the first two form factors in Table II are high, but the ratio falls rapidly. This is explained by the fact that trees other than dominants are growing into the lower diameter limits of the table and, other things being equal, the form factor is higher the more nearly the average height upon which it is based approaches the average height of all the trees in the stand. Later in the life of the stand the form factor is much more constant. Table IV in which the diameter limit is the same closely resembles Table II, while reference to Table III will show that with a high minimum diameter limit the period during which the form factor decreases is greatly prolonged. This is explained by the fact that suppressed and intermediate trees (*i. e.*, trees with less than the average height of the dominants) are growing into the lower diameter limit of the table for a longer period.

Increment. Properly included in yield tables but easily derivable from data given, increments are omitted in order that the tables may not prove cumbersome.

Table III gives the normal yield in board feet and additional cords, cubic feet and cords of better second growth stands. It differs from Table II in that the lower diameter limit is seven instead of two inches and board foot volumes are included. It is based on the same plots as Table II the trees between two and seven inches being omitted in the computations. Methods of construction were the same as for Table II.

TABLE III. NORMAL YIELD PER ACRE IN BOARD FEET AND ADDITIONAL CORDS, CUBIC FEET AND CORDS OF BETTER SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

Site Class I

(All trees 7 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. ft.	Height in feet	D.B.H. in inches	Volume per acre cu. ft.	Volume per acre cords	Volume per acre board feet	Volume per acre additional cords	Forest form factor
30	37	10.7	51.9	7.28	350	5.2	1,460	1.4	.636
35	147	48.4	57.0	7.86	1280	13.8	2,900	6.4	.465
40	186	70.7	61.3	8.45	1950	21.3	4,720	9.2	.450
45	205	89.4	64.8	9.00	2549	28.3	7,130	10.0	.440
50	216	105.8	68.1	9.48	3120	34.8	10,310	8.3	.433
55	223	120.9	71.0	9.97	3680	40.6	13,160	6.3	.429
60	226	135.4	73.6	10.53	4240	46.1	15,620	5.6	.426
65	227	150.1	75.9	11.08	4810	51.2	17,850	5.4	.422
70	226	164.3	78.0	11.59	5360	56.0	19,830	5.3	.419
75	224	178.6	79.8	12.10	5900	60.8	21,700	5.2	.415
80	220	192.4	81.5	12.62	6450	65.6	23,400	5.3	.411

Site Class II

(All trees 7 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. ft.	Height in feet	D.B.H. in inches	Volume per acre cu. ft.	Volume per acre cords	Volume per acre board feet	Volume per acre additional cords	Forest form factor
35	56	16.0	49.4	7.25	530	6.7	800	4.7	.671
40	104	35.0	54.5	7.85	1010	14.0	1,920	9.1	.529
45	133	51.3	56.7	8.41	1460	19.7	3,250	11.4	.502
50	157	66.0	59.4	8.78	1870	24.6	4,780	12.3	.477
55	175	79.9	61.6	9.15	2250	29.1	6,600	12.2	.459
60	188	92.8	63.2	9.51	2620	32.8	8,660	10.2	.447
65	197	105.7	64.4	9.90	2970	36.4	10,850	8.6	.437
70	203	117.9	65.4	10.32	3310	39.7	12,710	7.1	.429
75	206	130.0	66.2	10.75	3660	42.7	14,220	6.2	.425
80	207	141.8	66.8	11.21	4020	46.0	15,380	6.1	.424

Number of Trees per Acre. It will be noted that there are more trees per acre on site quality one than on two. This is due to the high diameter limit. While there are actually more trees per acre on quality two sites at a given age, as will be seen by reference to Table II, not so many grow into the limits of Table III in a given period of years, so that the number of trees included is greater on the better sites.

Board Foot Volumes. In obtaining board foot volumes the present milling practice throughout the region was carefully taken into account. Volumes are, therefore, actual not theoretical, and as they are based wholly on natural stands, represent a conservative minimum for fully stocked stands under forest management. Practically all hardwood is sawed through and through into round-edged lumber. Any tree which will given an eight foot log out of which a board with a minimum face of five inches can be sawed is considered merchantable. At the time of measuring the plots the top diameter and length of each log contained in the individual trees was calculated and recorded with due allowance for crook and defect. Board foot volumes of logs were computed by the use of Clark's International Log Rule which is shown by the sawmill practice of the region to be conservative. Mill tally studies on the Harvard Forest show slightly higher values than those in Clark's rule. In calculating the additional cords six board feet to the cubic foot and sixty-five cubic feet to the cord were assumed. This figure is admittedly but a rough estimate. Under favorable market conditions the cordwood in the trees two to seven inches in diameter, which is omitted in the table, could be utilized. The volume of this product may be found by subtracting the cord volumes given in Table III from those given in Table II for the same age and site class.

Table IV gives the normal yield in cubic feet and cords of inferior second growth hardwood stands. All trees two inches and over in diameter breast high are included. But one site quality, an average between quality one and quality two for

TABLE IV. NORMAL YIELD IN CUBIC FEET AND CORDS OF INFERIOR SECOND GROWTH HARDWOOD STANDS IN CENTRAL NEW ENGLAND

(All trees 2 inches and over in diameter)

Age in years	Trees per acre	Basal area sq. feet	Height in feet	D.B.H. in inches	Volume per acre cubic feet	Volume per acre cords	Forest form factor
17	1050	42.2	28.6	2.71	670	10.40	.555
18	1535	65.7	29.3	2.80	830	14.15	.431
19	1640	73.8	29.9	2.87	990	16.60	.449
20	1708	79.2	30.5	2.92	1130	18.06	.460
21	1750	84.0	31.1	2.95	1230	18.95	.471
22	1774	85.5	31.6	2.98	1300	19.54	.481
23	1778	87.0	32.1	3.01	1360	19.97	.487
24	1768	88.0	32.5	3.03	1400	20.30	.490
25	1743	88.2	32.9	3.05	1430	20.53	.492
26	1710	87.9	33.3	3.07	1440	20.72	.493
27	1671	87.4	33.6	3.10	1450	20.86	.494
28	1623	86.8	33.9	3.13	1455	20.88	.495
29	1575	86.1	34.1	3.17	1460	20.75	.494
30	1515	85.3	34.4	3.21	1460	20.63	.494

this type, is given. The construction of the table is similar to that of Table II.

Number of Trees per Acre. The gradual increase in the number of trees per acre between the ages of seventeen and twenty-three years is due to the fact that many trees are growing into the lower diameter limit of the table during this period — exactly the same effect as that produced by a high diameter limit in the case of Table III. After thirty years gray birch rapidly deteriorates, the rate of reduction in volume of the stand being dependent upon the percentage of this element in its composition. Cord volume falls off while cubic foot volume maintains a slight increase because more cubic feet of solid wood are required to make a cord as average diameters of trees become greater. The continuance of rise in volume after the culmination of basal area is due to the

fact that gray birch has relatively less merchantable length than all other hardwood species for its total height. For this reason it is an exception to the conclusion that the volume of a tree of given height and diameter in cords and cubic feet is the same, regardless of species.

APPLICABILITY OF TABLES

The individual plots from which the better hardwood tables were derived varied greatly in the proportions of the various species in mixture. Since this was found to have little or no effect on the volumes of these plots it is fair to suppose that the tables are applicable to a wide variety of mixtures. The test of the Harvard Red Maple Volume Table, described on page 14, indicates that even-aged second growth hardwoods on similar sites have much the same form regardless of species. Mill tally scales also appear to bear out this belief. If this is true, the present tables should be capable of wide use both in the determination of the present and future yields of individual stands, and in more general computations relating to the stand and growth of hardwoods throughout the region.

BOTANICAL NAMES OF SPECIES MENTIONED

(Botanical names are those given in Gray's *New Manual of Botany*, Seventh Edition)

BASSWOOD. *Tilia americana*, L.
BEECH. *Fagus grandifolia*, Ehrh.
BLACK ASH. *Fraxinus nigra*, Marsh.
BLACK BIRCH. *Betula lenta*, L.
BLACK CHERRY. *Prunus serotina*, Ehrh.
BLACK OAK. *Quercus velutina*, Lam.
BUTTERNUT. *Juglans cinerea*, L.
CHESTNUT. *Castanea dentata*, (Marsh.) Borkh.
CHESTNUT OAK. *Quercus Prinus*, L.
ELM. *Ulmus americana*, L.
FLOWERING DOGWOOD. *Cornus florida*, L.
GRAY BIRCH. *Betula populifolia*, Marsh.
HARD MAPLE. *Acer saccharum*, Marsh.
HEMLOCK. *Tsuga canadensis*, (L.) Carr.
HOP HORNBEAM. *Ostrya virginiana*, (Mill.) K. Koch.
PAPER BIRCH. *Betula alba var. papyrifera*, (Marsh.) Spach.
PIGNUT HICKORY. *Carya glabra*, (Mill.) Spach.
POPLAR. *Populus tremuloides* and *P. grandidentata*, Michx.
RED MAPLE. *Acer rubrum*, L.
RED OAK. *Quercus rubra*, L.
RED PINE. *Pinus resinosa*, Ait.
RED SPRUCE. *Picea rubra*, (DuRoi) Dietr.
SCARLET OAK. *Quercus coccinea*, Muench.
SHAD BUSH. *Amelanchier* sp.
TUPELO. *Nyssa sylvatica*, Marsh.
WHITE ASH. *Fraxinus americana*, L.
WHITE OAK. *Quercus alba*, L.
WHITE PINE. *Pinus strobus*, L.
YELLOW BIRCH. *Betula lutea*, Michx. f.

FIGURE 1. Distribution of *Hylobius pales* and the White Pine (*Pinus strobus*) in the United States.

HARVARD FOREST

BULLETIN NO. 3

RICHARD T. FISHER, *Director*

THE LIFE HISTORY AND CONTROL OF THE PALES WEEVIL

(HYLOBIUS PALES)

BY

H. B. PEIRSON

HARVARD FOREST, PETERSHAM, MASS.

1921

COPYRIGHT, 1921
HARVARD UNIVERSITY PRESS

CONTENTS

Introduction 5
History and Distribution 6
Nature of Damage 8
Food Plants 14
Feeding Habits of Adult 15
Migration 16
Seasonal History and Habits 17
Description 19
Similar Species 22
General Behavior as Affecting Control 23
Natural Enemies 26
Fungi 26
Advised Methods of Control 28
Control on Cut-Over Pine Lands 29
I. In Natural Reproduction 29
II. In Plantations 31
Control on Open Land 31
Bibliography of Economic References 33

THE LIFE HISTORY AND CONTROL OF THE PALES WEEVIL (*HYLOBIUS PALES*)[1]

INTRODUCTION

IT is a notable fact that in spite of the serious damage caused by *Hylobius pales*,[2] it escaped all notice as an economic forest pest, in its adult stage, until 1914, although it is a native of the United States. At this time Professor E. E. Carter of the Harvard Forest School, made an effort to ascertain the reason for the almost universal failure of coniferous plantations on recently cut-over pine woodlots. He found that the failures were due, not to climatic or other natural causes, as has been supposed, but to the presence of *Hylobius pales* Herbst, a snout beetle which feeds voraciously upon the bark of coniferous seedlings. Furthermore, he found that the beetles have a wide range of coniferous food plants and that an infestation lasts for several years. The reason for overlooking the seriousness of the pest is very apparent when one considers that dead two or three year old pine seedlings, amongst the vast amount of both growing and decaying vegetation, are very inconspicuous even when one is looking for them. Once girdled, the seedlings rapidly deteriorate and in falling over are covered up with dried leaves and other vegetation. Previously this beetle had been recorded as breeding in stumps and logs of recently felled trees, but, as far as can be determined, never as feeding on coniferous seedlings.

The present study of the life history and control of the pales weevil was started in September of 1919. It is based almost entirely upon results obtained at the Harvard Forest,

[1] Work done in coöperation with the Entomological Laboratory of the Bussey Institution. Contribution No. 180.

[2] Classification according to Blatchley and Leng. Order, Coleoptera: Family, Curculionidae; Sub-family Curculioninae; Tribe, Hylobiini.

Petersham, Mass. Here an admirable set of conditions exist for the study of such a problem. Yearly cuttings with consequent reproduction and plantations offer advantages which otherwise would require a series of years to obtain. Varying conditions of moisture, soil, and exposure have also helped materially in dealing with the problem. Nearly all trees native to New England are found either in the Forest or in close proximity to it, so that the range of food-plants in different latitudes was apparent without recourse to other localities, although verifications were obtained wherever possible.

The author is indebted to both Professor C. T. Brues and Director R. T. Fisher of the Harvard Forest School, for their aid in carrying out the following work. Thanks are also due Mr. E. E. Carter, of the U. S. Forest Service, for turning over notes made on the destructiveness of the pales weevil while he was connected with the Harvard Forest School, as Assistant Professor of Forestry.

HISTORY AND DISTRIBUTION

Hylobius pales is undoubtedly a native of the United States and apparently occurs no where else except in Canada. It was first recorded as a destructive insect about 1840 by Wilson in "American Ornithology." He records the larvae as killing large areas of conifers by burrowing in the trees. His record is undoubtedly an exaggeration or mistaken identity, due to his lack of acquaintance with the pales weevil. The next record of note is contained in Harris's "Insects Injurious to Vegetation," (1852) in which he states that he "found the beetles in large numbers during May and June, on board fences, the sides of new wooden buildings, and on the trunks of pine trees." Numerous later writers mention collecting the beetles. Packard (1890) collected larvae and pupae from pine and saw the adults flying. Felt (1906) records the presence of the adults on pine and in mill yards.

FIGURE 2. White Pine Seedling Showing Characteristic Injury.

A very similar species, *Hylobius abietis*, occurs throughout Europe, and to quote Gillander in his account of the beetle in his book entitled "Forest Entomology," "This is considered one of the worst insect enemies the forester has to deal with; in fact, it may be said to be the most dreaded beetle." The habits of the European species are almost identical with those of *Hylobius pales*. No method of control has been found in Europe which will permit the planting of seedlings on cutover areas until three years after cutting. Numerous methods of control are mentioned by English, German, and Russian entomologists, but all conclude in stating that plantations should not be started for two or three years after the tract has been cut over.

The distribution of the pales weevil seems to be general throughout the Eastern half of the United States and in South-eastern Canada. Specimens have been collected from Minnesota, Michigan, Indiana, Illinois, Missouri, Arkansas, and Mississippi on the west; Florida on the south, and South-eastern Canada on the north, with collections all along the Atlantic sea-board (Fig. 1).

Although in New England the white pine is the most favored food, it is apparent that in a large part of the area trees other than white pine must be fed upon, due to the restricted distribution of the tree as shown by the accompanying map. From reports obtained, however, it seems to be true that the beetle is much more abundant in the white pine area, especially where frequent cuttings are being made.

NATURE OF DAMAGE

The adult beetles feed on the tender bark of coniferous seedlings, oftentimes entirely stripping the bark from the stem and side branches. The most characteristic injury, however, is the removal of the bark in irregular areas leaving numerous criss-cross ridges. The beetles are voracious feeders and will kill a three or four year old white pine seedling within a

very few days. As many as thirty beetles have been found around the base of a single seedling.

It has long been observed in New England that it is almost impossible to secure a reasonably pure stand of white pine reproduction promptly after the removal of older stands of

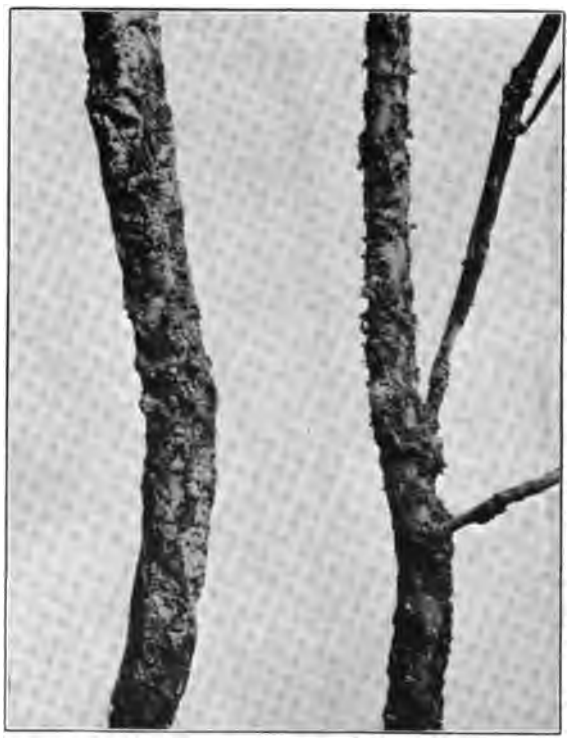


FIGURE 3. Typical Injury on Main Stem of Seedlings Showing Numerous Criss-Cross Ridges Left by Beetle.

pine, even though large numbers of seedlings may be present. Several causes have been suggested to account for the loss of these seedlings. It has been suggested that the young hardwoods already present, entirely crowd out the pine, or that extreme acidity of the soil, due to the decomposition of the leaf litter, does not favor the growth of the pine seedlings. These explanations do not, however, satisfy all conditions,

for damage is just as prevalent in grass covered areas, as was shown by Carter, such as pastures where limby pasture pines have been cut down to give the young seedlings a better chance to develop. In one case a broken stand of limby, pasture grown pine was removed from over a veritable carpet

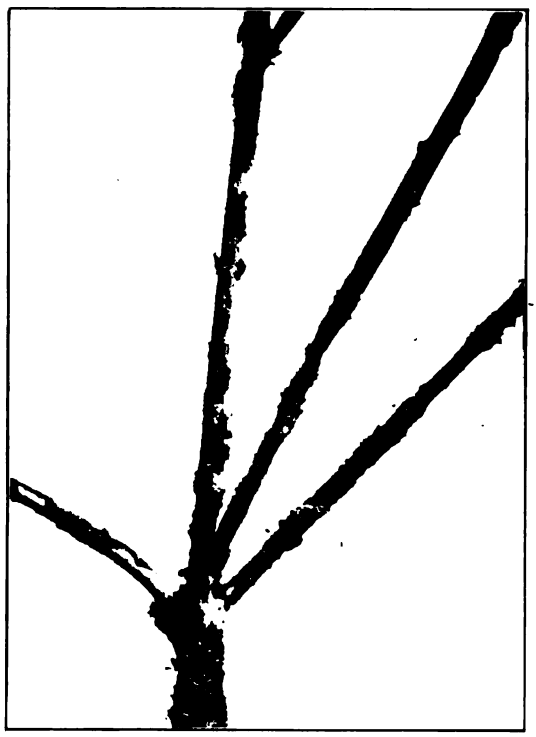


FIGURE 4. Typical Injury Showing Girdling Effect on Dead Seedling Killed by *Hylobius pales*.

of white pine seedlings, which were from two to six inches in height. Three years later there were left less than ten per acre of these thousands of young pines. In another case a stand of white pine was removed, the area cleared and set out as a nursery with white pine. The beetles were immediately attracted to the spot and completely ruined the nursery.

The beetles have been collected wherever a pine cut has been made.

As an example of how little cutting it takes to attract the pales weevil, a small white pine which was growing in a stand of gray birch was cut. The tree was about twelve feet in height with a stump diameter of four inches. All the slash was immediately removed, except for a few twigs that were placed on the stump and burned thoroughly so that the outer portion of the stump was completely charred. Fourteen white pine seedlings were then set out around the stump covering an area of about twelve feet in diameter. In two weeks from cutting eleven of the seedlings had been damaged by the beetle. The area where this experiment was carried on was more or less covered with scattered white pine seedlings, but none of these had been harmed previous to the cutting of the single white pine.

The beetles are attracted purely to areas where lumbering operations have been carried on, such as the felling of trees and the sawing and stacking of lumber, or to areas where trees have been destroyed in such a manner that the odor of pitch or sap is still apparent.

In order to ascertain the amount of damage and probable length of infestations, large numbers of counts were made covering approximately forty acres of cut-over pine lands. Included in this area were tracts which had been cut from one to five years previously. In making these counts typical areas varying from 225 square feet to areas of 3000 square feet, depending on the density of the pine seedlings, were marked off, and all of the seedlings counted and tallied under the heads of (1) Healthy, (2) Dead from Unknown Cause,(3) Killed by *Hylobius pales*, (4) Injured by *Hylobius pales*. Figure 5 shows a typical area as copied from the field diary. As much as possible these plots were so scattered in the areas that a general average could be obtained. The counts from the different tracts were then sorted according to age of the cut so that the figures, for example of the 1919

cut, could be averaged together. In this way the degree of infestation was obtained, for not merely one cut-over area, but for the general district around Petersham where the counts were made. See table on the following page.

It is apparent then, that damage occurs the first three years after a cutting of white pine, ninety-eight per cent of

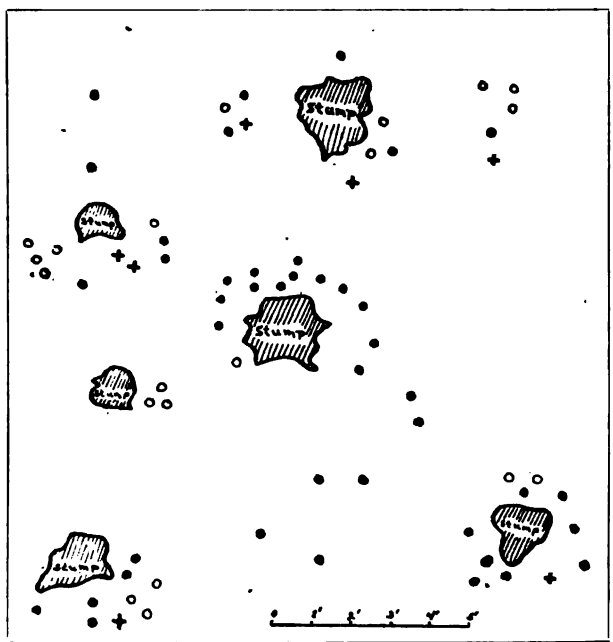


FIGURE 5. Typical First Year Infestation as Copied from Field Diary.
+ Healthy White Pine Seedlings, 28.2%.
o Seedlings Dead from Unknown Causes, 11.27%.
● Seedlings Killed by *Hylobius pales*, 60.53%.
None Merely Injured.

it occurring the first two years, and that after the third year no new injury is done.

In one location about one million feet of lumber were piled at one end of a pasture which was fast being reforested by natural pine seedlings. The lumber was largely white pine. The beetles were immediately attracted in large numbers and the succeeding infestation proved to be one of the most

SUMMARY OF COUNTS MADE IN OCTOBER, 1919

Date of Removal Cutting	Year of Infestation	Approx. Size of Areas Examined	Percentage of Trees Killed during Feeding Season
1918–1919	First	23.95 Acres	40%
1917–1918	Second	7.95 "	40% (Additional to above)
1916–1917	Third	13.7 "	2% " " "
1915–1916	Fourth	1.6 "	0%
1914–1915	Fifth	10. "	0%

severe in the locality. The center of the infestation proved to be the lumber, and from here the beetles worked out, killing practically all of the seedlings as the infestation spread. At the beginning of the second year of infestation there was hardly a live seedling to be found within five hundred feet of the lumber. Even the maturing twenty to thirty year-old white pines surrounding the pasture were attacked, the beetles feeding on the tender twigs. The large trees were by no means seriously damaged but most of the twigs fed upon were killed.

In a like manner experiments showed that freshly cut slash will attract the beetles even when carried a long distance from the cutting. Freshly cut pine logs when piled in an open pasture preparatory to sawing attracted thousands of the beetles.

Experiments carried on in the laboratory only emphasized the fact that the beetles are endowed with an exceedingly acute sense of smell. Especially arranged chambers with connecting galleries were used for testing their power of smell. A small freshly cut pine twig was placed in one chamber. The beetles liberated in another chamber soon sensed the odor and crowded over one another in their effort to get at the twig. The beetles had not been fed for a day, so that hunger undoubtedly hastened the reaction.

FOOD PLANTS

The beetle has a wide range of food plants and has been found feeding upon all of the coniferous species growing in the vicinity of fresh cuttings in Southern Maine and in Central Massachusetts. White pine is, without any question, the favorite food in these localities, but in the absence of this tree other coniferous seedlings are voraciously fed upon. In one place on the Harvard Forest a plantation of red pine, *Pinus resinosa*, was started on an area which had been cut over two years previously. The first year after the cutting, a heavy infestation of the beetle occurred, the majority of the white pine seedlings, which, due to proper forest management were reforesting the area, having been killed. The second year as there were comparatively few white pine seedlings present, the beetles attacked the red pine, which had just been set out, and either killed or injured approximately forty-eight per cent of the trees. These seedlings were five-year old stock, the bark of which is relatively rough and heavy.

The general susceptibility of the young seedlings seems to depend largely upon the nature of the bark. Those seedlings having relatively thin, tender bark, being favored for food. The exuding of pitch retards feeding to a noticeable degree. Injury likely to cause death is confined to trees under three feet in height. In the breeding cages, fresh white pine chips were the most favored food, but in the absence of other foods, even hardwoods were fed upon.

The following is a list of known food plants. Records have come to notice of the beetle having been found on plum and cotton, but no verifications have been obtained.

Pinus strobus L. White pine.
Pinus rigida Mil. Pitch pine.
Pinus resinosa Ait. Red or Norway pine.
Pinus ponderosa Laws. Western yellow pine.
Pinus sylvestris L. Scotch pine.
Larix laricina (Du Roi) Koch. American larch.

Larix larix (L) Karsten. European larch.
Picea rubra (Du Roi) Dietr. Red spruce.
Picea Abies (L.) Karsten. Norway Spruce.
Abies balsamea (L.) Mill. Balsam fir.
Tsuga canadensis (L.) Carr. Hemlock.
Pseudotsuga taxifolia (Lam.) Britton. Douglas fir.
Thuja occidentalis L. Arbor Vitae.
Juniperus communis L. Common juniper.
Juniperus virginiana L. Red cedar.
Betula populifolia Marsh. Gray birch.
Fraxinus americana L. White ash.

FEEDING HABITS OF ADULT

Extensive observations have shown that *Hylobius pales* is typically a nocturnal feeder, although a few beetles can practically always be found feeding during the day. These, however, are usually feeding on the underside of twigs or at the base of the seedling just below the surface of the ground. In the insectary one cage was kept dark by covering with a heavy manila bag. In this cage beetles could be found feeding at all times. In the field the beetles are rarely found feeding in the direct sunlight except after long, heavy storms, or during warm periods of weather which have been directly preceded by low temperatures.

The beetles start feeding soon after sundown and by midnight the majority of them are feeding, or at least are active. By sunrise the majority of the beetles have sought shade in the soil around the base of the seedlings. Many merely hide on the underside of fallen leaves. This habit was taken advantage of in collecting the beetles, pine chips being placed at the base of the infested trees, and the beetles collected from under these. It is a common occurrence to find from ten to fourteen beetles at the base of a single seedling, although their color and habit of feigning death tends to make them easily overlooked.

The beetles are hearty feeders and, when necessity demands, will feed on a great diversity of food. They are not gregarious in their feeding habits, seldom more than three

being found close together on the same twig. A favorite place of feeding is in the crotch of a twig and the main stem where the wood is particularly sappy. The new buds are also favored in some localities, although this does not seem to be general. Oftentimes seedlings may be entirely stripped, not a vestige of bark remaining. That portion of the seedlings from which the needles have fallen is usually attacked first.

Very often seedlings which appear healthy or even slightly yellow, and which show no signs of having been attacked above the ground, are found to have been girdled or partially girdled just below the undecomposed carpet of needles or other vegetation.

Moisture is an essential element in determining the degree of infestation. Seedlings growing amongst moss are especially favored, whereas those growing on exposed dry places are far less susceptible to attack. In order to further exemplify this point, which was quite apparent in different localities, four large plots were marked out and all seedlings on each plot counted and examined. The plots were adjacent to each other so that soil, temperature, and light conditions were as nearly identical as possible. On two of these plots the ground cover was entirely removed so that the bare soil was visible. As the soil was rich in humus there was little likelihood of the seedlings drying up. Although this experiment has been running only about ten weeks there is already a noticeable difference in the degree of infestation between the cleared and uncleared plots.

MIGRATION

Observations made in the field tend to show that the beetles are present in small numbers through the woods regardless of whether there have been recent cuttings or not, and that they are attracted from long distances to freshly cut areas. It is this habit of migrating that causes the beetle to be of

such economic importance for it concentrates its attacks on areas where the young seedlings are just coming up to replace the cut timber.

The adults are strong fliers, the majority of them apparently flying within twenty feet of the ground, as is shown by the fact that mature pines are seldom fed upon above this height. The beetles have been observed hovering about in the air for long periods. An examination of the wings shows a strong development. It is interesting to note that the European species, *Hylobius abietis*, is said by European entomologists not to fly, although the wings show a development similar to that in *H. pales*.

An interesting example of their migrating habits occurred on a tract where there was a fairly heavy infestation of the beetles in a red pine plantation, which bordered one of the main roads. Large numbers of white pine logs had been hauled into a field on the opposite side of the road, preparatory to sawing. As the infestation was in its third year, thousands of the beetles migrated to the log-piles. In order to reach these it was necessary for them to pass through a fringe of pine trees bordering the road. Large numbers of the beetles must have stopped here to feed, for fully half of the young twigs showed signs of having been fed upon, large numbers actually being killed.

SEASONAL HISTORY AND HABITS

The adult beetles emerge from hibernation during the period from the latter part of April to the latter part of May, depending upon climatic conditions. The majority become active at approximately the same time. They immediately begin feeding and remain near the place of emergence until the middle of June. It is at this time, that in the third year of infestation, the heaviest migration takes place. The beetles swarm to some locality where, preferably, a white pine logging operation has just taken place. During their

flight they may stop for a short time to feed on mature pine. On reaching the new breeding grounds they may feed for from one to two weeks, upon the pine chips, slash, or even upon the bark of pine logs, if no suitable seedlings are present.

The small, pearly white eggs are usually laid singly, either in freshly cut pine logs or in the roots of fresh cut pine stumps. The beetles make a small perforation in the bark and crowd the egg into this opening. When the breeding takes place in log piles the eggs are almost invariably laid on the lower side of the under logs, where they rest upon the ground. Other conditions being favorable the eggs are usually laid in the ends of the logs just beneath the bark, around areas where limbs have been cut off, or in areas where the bark is reasonably thin and smooth. Large numbers of eggs are usually laid fairly close together. When breeding takes place around stumps the beetles burrow down into the soil for a distance of from three or four inches to a foot or more, and lay their eggs in small perforations made in the roots. Apparently, they prefer the underside of the roots for egg laying.

The eggs hatch in from ten days to two weeks and the small, footless, white grubs immediately begin burrowing beneath the bark. Unlike bark beetles, they apparently follow no direction, merely going where the food may seem most tempting. The larvae are gregarious and loosen the bark over large areas. As is the case with many other bark borers, turning the infested logs so that the direct rays of the sun strike the areas being tunneled, soon kills the larvae, due probably, to lack of moisture. They require nearly two months to mature, at which time they have attained a length of approximately one centimeter.

About the first of September the larvae pupate beneath the bark in individual cells, penetrating about one-quarter inch into the sap-wood and covered over with frass. In this stage they remain until about the first of October, although

some adults may emerge as early as September fifteenth. The adult beetles, after emergence, begin feeding upon the nearest pine seedlings. It is at this time that the most severe damage is done. As one seedling is stripped of its bark the beetles move on to the next, so that in areas where the seedlings are not thickly carpeted, every seedling may be killed or damaged.

Beetles have been found feeding as late as November eighteenth in the vicinity of Petersham, Mass., and as late as the first of December in an out-of-doors cage in Boston, Mass., the difference in altitude being a thousand feet. At Petersham, the ground had been covered with a light fall of snow for nearly a week, and frost had penetrated the ground to a depth of three inches.

By the twentieth of October the majority of the beetles have gone into hibernation. The winter is spent, for the most part, in the soil at the base of the seedlings upon which the beetles have been feeding. They penetrate the ground to a depth of six inches, where there is a tendency for them to congregate in groups. Some pass the winter in hibernation beneath stones at a similar depth. The different stages overlap to a considerable extent, larvae having been found as late as October eighth. Some individuals undoubtedly pass the winter in the larval or pupal stage in stumps or logs.

DESCRIPTION

Hylobius pales Herbst.

Curculio pales Herbst. Käfer, vol. 7, p. 31 (1797).

Pissodes macellus. Germar, Coleop. Spec., p. 319 (1827).

Hylobius pales. Dejean, Cat. Coleop. Coll. Dejean (1837).

Hylobius americanus. Dejean. Cat. Coleop. Coll. Dejean (1877). (Later edition).

Hylobius pales. Schönherr, Gen. Sp. Curculionidum (1842).

Hylobius pales. Leconte and Horn., Proc. Am. Philos. Soc., vol. 15, p. 140. (1876).

Hylobius pales. Blatchley and Leng, Rhynch. No. Am., p. 186 (1916).

The Adult

The adult (Fig. 6) is an oblong, robust, dark reddish brown to black beetle. Length 7–10 mm. the elytra have scattered small tufts of rather long gray or yellowish hairs, those be-

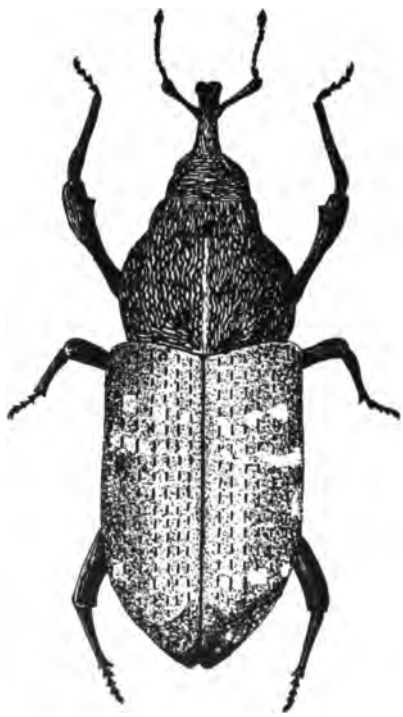


Figure 6. The Pales Weevil (*Hylobius pales*): Adult Greatly Enlarged.

hind the middle arranged to form two oblique cross bars. These, however, are not always distinct.

The *head* is sub-opaque, densely though not coarsely punctured. The *eyes* are large, coarsely granulated, transverse, separated by their own diameter, not contiguous beneath. The *antennae* are stout, more or less completely elbowed, the scape barely reaching the eye. Joints one and

two of the funicle are distinctly longer than the others, the first longer than the second, three to six moniliform, seven much broader, forming part of the club. The club is compact, oval, pointed, ringed, and wholly pubescent and sensitive. The antennae are inserted in front of the middle, their insertion being visible from above. The *beak* is free, stout, cylindrical, feebly curved, length approximating that of thorax. The beak is grooved for the reception of the antennae, the grooves being directed towards the lower part of the eyes. *Mouth parts.* Mandibles with two apical teeth, the lower one a little shorter than the upper and in addition having a little cusp on the inner edge so that they are in reality three toothed. The labial palpi are large, the mentum transverse.

The *thorax* is broader than long. The prosternum is broadly emarginate in front and fringed with long yellow hairs. The mesosternum is moderately long. The humeri are not truncated by protruding sides of mesothorax. The gular margin is prominent. The legs are stout, front coxae contiguous, femora club-shaped and strongly toothed. The tibia are rather slender, not narrowed towards tips, sinuate on the inner side, corbels narrow, terminal hook strong. The terminal edge of hind tibia is double. The third joint of tarsi is dilated, spongy beneath, claws simple, diverging.

The *abdomen* is sparsely and rather finely punctate. Lateral angles of first ventral segment covered by elytra, suture in front of second, broadly angulated at middle. The second and fifth ventral segments each as long as the third and fourth united. The male has an additional anal segment. The disc of elytra is distinctly flattened, striae with large, oblong punctures, intervals rather narrow, (flat, rugose-punctate).

The Egg

The egg is pearly white, slightly oblong, and is equally rounded at both ends. It is 1 mm. in length by .5 mm. in

diameter. The chorion is smooth, slightly glossy, and is of medium toughness.

The Larva

The larva (Fig. 7) is a white, robust, cylindrical, footless grub. The head is light brown. The spiracles are very prominent and are oblong in shape. When full grown the larva is approximately 12 mm. in length.

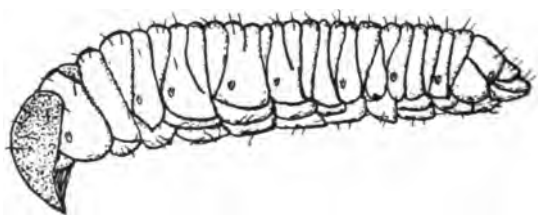


Figure 7. Larva of *Hylobius pales*. Greatly Enlarged.

The Pupa

The most characteristic point in identification in this stage is the pupal cell which is found beneath the inner bark of infested logs or stumps. The cell is made in the sapwood and is from one-quarter to one-half inch in depth, and is arched over with a thick cover of chips which the grub has chewed off. The pupa, which is approximately 10 mm. in length, is found beneath this cover of fine sawdust or chips. (Fig. 8.)

SIMILAR SPECIES

The Genus Hylobius includes about ten known species, of which *pales* and *confusus* are native to the United States.

Hylobius confusus Kirby, closely resembles small forms of *H. pales*. The head is more shining, less densely, and more coarsely punctured. Length of adult from 6–8 mm.

Pissodes strobi Peck, is probably the beetle most liable to be confused with the pales weevil. The simplest way of differentiating them from each other is to note the antennae.

In the pales weevil the antennae come out nearly two-thirds way down the beak, whereas in the white pine weevil the antennae are inserted about midway on the beak. The white pine weevil is smaller and generally of a reddish-

FIGURE 8. Pupa Cases of *Hylobius pales* Beneath Bark. Actual Size.

brown tinge with prominent light markings on the elytra. This beetle also feeds to a slight extent on the bark of white pine, prior to egg laying.

GENERAL BEHAVIOR AS AFFECTING CONTROL

In an effort to find a feasible method of controlling the beetle by the use of repellents, poison baits, or banding materials, experiments were carried on both in the field and

in the laboratory. It was essential that the cost of application be kept low, as will be explained under General Control Methods. Plots were treated with repellents such as borax, lime, and napthaline, others were treated with Tanglefoot.

Owing to the fact that the beetles thrive best in a rich humus soil it was suggested that the application of lime might prove of benefit in keeping the degree of infestation low. This, however, proved to be of no practical use as the beetles were in no wise repelled by the lime. More extensive experiments might prove otherwise, but this is doubtful.

Plots were also treated with borax and napthaline, the substances being placed around the seedlings in powdered form. The cost of application depends almost entirely upon the prevailing labor prices. Borax proved to be of no use. On the other hand napthaline has a negative chemotropic effect on the beetles. The degree of the repellence does not appear, however, to warrant the application of it on a large scale.

Tanglefoot acts as a decided barrier due entirely to the stickiness of the substance, the odor having nothing to do with its action. The Tanglefoot was placed in bands around the base of the seedlings on the main stem, about one-half inch from the ground level. The beetles will try again and again to cross a band of the substance, there being no hesitation until the first four legs are completely entangled. Numerous factors tend to discourage the use of banding materials on seedlings in the control of *Hylobius pales*. In the first place the effect upon the growth of the seedlings is yet to be worked out. The bark on a white pine seedling is very tender and would probably be penetrated easily by oils which would interfere with the growth of the tree. In the second place observations have shown that the beetles will feed on the stem beneath the soil and also that they are strong fliers, which latter characteristic would enable them to get above the band. The fact that the band must necessarily be near the surface of the soil means that the winds

and rains would tend to cover it with material from the ground cover and soil, that would permit the beetles to cross. Then there is the item of cost which would necessarily be quite large, due to the labor of treating the seedlings. This would immediately eliminate the treatment of natural seedlings. The labor involved in treating seedlings in plantations as they are being set out would not, however, be prohibitive. The seedlings can easily be bent "U-shaped" and dipped in the banding material just as they are being transplanted from the nursery.

The beetles proved to be positively chemotropic to odors arising from citrus fruits. This led to the idea that poison baits might possibly be used. Experimentation, however, proved that the attractive power of the fruit was easily offset by the presence of pine chips. As these latter are invariably present on cut-over areas, poison baits in which an aromatic oil is the basis, would prove of little or no avail. Other types of baits have not as yet been tried.

The habit of feigning death is highly developed in *Hylobius pales*. If disturbed when feeding, the beetles drop to the ground and crossing their tibiae assume a position as in death. If disturbed by jarring or by the breath while walking, they immediately become motionless in which state they will remain for some time after the apparent danger is past. This habit of feigning death, together with their natural soil-like color, make them easily overlooked when collecting, so that sifting of the soil or placing upon white paper was frequently resorted to. It was interesting to note that rubbing the tarsi, even with a dissecting needle, would invariably arouse the beetles to activity.

The instinct of self defence is decidedly lacking. When attacked by other insects, such as ants, the beetles offer no semblance of defence. An example of this was noticed when several mound building ants, *Formica exsectoides*, attacked one of the beetles. The pales weevil was immediately rolled over on its back, in which position it folded its legs and

antennae close to its body, in short, apparently feigned death. The ants were unable to reach any vital point due to the heavy chitinous coating of the beetle. They contented themselves with chewing off the tarsi, the beetle offering no resistance. This very apparent lack of ability to defend themselves, even against smaller enemies, is probably due to a long dependence upon their protective coloring and heavy chitinous coating which offers considerable protection.

The beetles are by no means weak, for they are able to move bodies weighing several times their own weight. Then again they are equipped with sharp, powerful mandibles with which they could inflict severe wounds upon insect enemies, if this strength were only supplemented with quicker actions.

NATURAL ENEMIES

The pales weevil has few natural enemies, and these cannot be relied upon to hold the pest in check. Up to the present writing no insect parasites have been bred from the larvae, although parasitic Diptera and Hymenoptera have been repeatedly taken in the vicinity of logs and stumps in which the weevils have been breeding. The beetle, however, is admirably protected from insect attack throughout its life.

A few of our native birds feed upon the adults, but as the latter come out in numbers only at night, few are killed. Woodpeckers often feed upon the larvae.

It is a common occurrence to find mole tunnels in areas where the infestation is heavy, and undoubtedly the moles feed upon the adults. A small snake has also repeatedly been found at the base of infested trees.

FUNGI

One of the imperfect fungi *Sporotrichum globuliferum*, undoubtedly plays an important rôle in the control of Hylobius pales, and often attacks other Coleoptera and Hemiptera. The fungus spores are wide-spread, diseased beetles or larvae

being found under a great variation of conditions. The maturation of the fungus, however, depends to a great extent upon an abundant supply of moisture.

The fungus appears as cottony masses breaking out through the intersegmental membranes, joints of the legs, and end of the beak. In advanced stages the beetles become practically covered with the mycelium and fruiting bodies. Stephens [1] describes the fungus as follows, "Hyphae widely spreading, much branched, conidiophores simple, short. Conidia acropleurogenous (born on sides of apex). Hyphae hyaline in more or less cottony masses." The mycelium may at times nearly fill the body cavity.

In an endeavor to study the possibilities of using the fungus as an artificial control measure, cultures were grown on potato agar. The fungus grows readily at ordinary room temperature. A study of germinating spores showed that branching begins to take place the fourth day. The growth is not rapid and care must be taken to prevent contamination, as molds quickly outstrip the fungus in growth. Colonies of the fungus from one to two square inches in size require approximately two weeks to grow.

In the majority of cases the beetles probably become infected through feeding, as this method of inoculation proved to be the most satisfactory in the laboratory, although dipping the beetles in a mixture of spores suspended in water gave satisfactory results. The beetles are killed within four days from inoculation. Checks were of course kept, and in no cases did these become infected. A mite was found in connection with the fungus which may possibly aid in carrying the spores.

Cultures of the fungus were transferred to a medium of boiled rice which was mashed so as to give a reasonably smooth surface upon which the fungus could easily be examined. Growth was noticed the day following inoculation. The growth on rice permits an easy dissemination of the

[1] "The Fungi which Cause Plant Diseases."

fungus in the field, the rice merely being spread broadcast around the base of pine seedlings. The rice apparently has no attractive power to the beetles, but merely serves as a spreading agent, the beetles becoming infected through actual contact.

Owing to the fact that the virulence of the organism depends almost entirely upon moisture, and that the fungus is

FIGURE 9. Beetle Infected with *Sporotrichum Globuliferum*.

apparently widespread, regardless of artificial dissemination, its use as a control method would hardly be worth while. Nevertheless it is true that under favorable conditions the fungus takes a heavy toll from the beetles. This fact was clearly presented in a breeding cage containing about one hundred and fifty adults. The cage was kept fairly damp and two or three diseased beetles left within. At the end of two months nearly all had succumbed to the fungus.

The conditions affecting the spread of the fungus amongst larvae, appear to be identical with those affecting the adult. Larvae feeding beneath the bark of round-edged lumber, or in logs which are exposed to dampness, become infected with the fungus. As the larvae are gregarious in their feeding habits the mortality is increased to a considerable degree.

METHODS OF CONTROL

The control of a forest pest must necessarily be carried on at a minimum of cost, and in the case of the pales weevil, practi-

cally devolves upon some form of forest management, other methods previously mentioned having thus far proved of little avail. There are two distinct types of infestation to be dealt with: First, that occurring on cut-over areas, and second, that occurring in pure stands of seedlings such as forest nurseries, plantations, and natural pine reproduction on open pasture land.

CONTROL ON CUT-OVER PINE LANDS

I. *In Natural Reproduction*

In view of the fact that the beetle destroys eighty per cent of the coniferous seedlings on a freshly cut area, it is obvious that if a large enough number of seedlings can be made available this damage can, to a great extent, be offset. If then, for example, a cut-over area could be started with ten thousand or more seedlings per acre, enough would remain, after the ravages of the beetle, to form the basis of a valuable mixed stand of hardwood and softwood.

Various methods of handling pine stands have been tried out on the Harvard Forest and these are explained in an article by R. T. Fisher and E. I. Terry entitled, "The Management of Second Growth White Pine in Central New England."[1] In brief it can be stated that the so-called shelter wood method has resulted in a reproduction of pine varying from three thousand to twenty-five thousand seedlings per acre. In order to obtain these results a thinning is first made to stimulate pine reproduction that will be available when a clear cut is made. If the clear cut is to be made during the fall or winter following a heavy fall of seed, a preliminary thinning is not necessary. After the cutting, the slash is burned in piles. The new crop on the cut-over areas is then weeded usually twice, depending upon the site. The first weeding is done when the reproduction is from three to five years old, and the second during the period between the

[1] Journal of Forestry, vol. xviii, no. 4, April, 1920.

eighth and tenth years. This method of management results in a good mixed stand in spite of the damage done by the pales weevil. It is well to bear in mind that the pure pine stand as found in Central New England is simply a transition type, which has encroached upon open pasture lands, and is being replaced after cutting by mixed hardwood, except upon thin-soiled or sandy areas, in which localities the soft woods thrive best. It is hardly worth while then to strive to obtain pure stands of pine on cut-over areas.

Year-old seedlings are seldom attacked. This is undoubtedly due to the small amount of sap which would be present. If a cutting is made in a seed year the young trees have that year to grow, very little damage resulting. As the beetles migrate to some extent in the fall, the infestation would be much lighter the second year, and by the third year would be almost a negligible quantity. Unfortunately it is not economically possible to cut only on seed years as these occur at intervals of three years, or if the climatic conditions are unsatisfactory a six-year period may elapse between heavy seed years, and in some cases an even longer time.

Owing to the fact that the beetles are attracted to cut-over areas by the odor given off by the pine stumps, slash, logs, or boards, it is advisable to eliminate as much as possible these agents from the area being reforested. New England lumbermen almost invariably leave the slashings resulting from logging operations in long windrows, which usually cover nearly one-third of the cutting, thus preventing the new forest from growing in this area. It is advised that this slash be piled over the pine stumps and thoroughly burned in the early spring. This not merely does away with the slash and its resulting odor of pitch but also chars the stumps which lowers their attraction for the beetles. This operation will not prevent an infestation, but will mitigate it.

Large adjacent cuttings made in consecutive years only tend to augment the primary infestation. This means that there will be an overflow of the beetles from the freshly cut

area on to the older cut, thus endangering the young coniferous growth that may have escaped the first infestation.

II. *In Plantations*

At the present writing it is not advisable to start coniferous plantations, using species native to New England, on cut-over pine lands during the first two seasons after cutting. The resulting plantations are sure to be seriously damaged and in some cases completely destroyed. A promising, inexpensive mode of entirely eliminating this loss is at present being worked out and it is hoped that by the end of another growing season satisfactory results will be available.

In brief, the idea being tried out is to burn all of the slash over the stumps in the early spring following the cutting, and to eliminate all coniferous seedlings on the cut-over areas by pulling them up and burning. It is taken for granted that the plantations are being set out due to the fact that the reproduction present on the area is either very scant or else unsatisfactory in other ways, so that the labor of eradicating the seedlings would be comparatively slight. If this is done in the early spring before the hardwoods leaf out, a man or boy can cover several acres in a day. When the adults emerge in the early fall from the pupal cells they are voracious feeders and if food is scant or absent they will migrate to some more favorable location, as observations in the field have shown. This means that the following Fall the plantation could probably be set out without loss from the beetles, or possibly the following Spring.

CONTROL ON OPEN LAND

It is a common occurrence in New England to see pasture land bordering pine woods literally carpeted with natural pine seedlings which are destined eventually to make pure pine stands. Oftentimes limby pasture-grown pines of considerable size may occur scattered over these areas. In order

to prevent loss to such beds of seedlings, which are a decided asset to the owner, certain policies must be adhered to.

In the first place the overtopping pasture pines must not be cut if seedlings are present until these reach a height of at least three and one-half feet. If cut then the slash should be burned over the stumps or carted away. In this way serious damage can be averted.

In the second place it is a common practice to stack the freshly sawed lumber in open pastures. The beetles being attracted by the odor from the lumber will swarm to the piles in great numbers, and if seedlings are present, as is often the case, the resulting damage is sure to be great. It is advised, then, that pine lumber be piled in areas where seedlings are not present. In a like manner it is sometimes customary to haul the logs out of the woods and to pile them in an open field near the mill site preparatory to Spring sawing. These pine logs serve as a breeding ground for thousands of the beetles, and if coniferous seedlings are present they are sure to be destroyed. If possible the logs should be sawed before the beetles emerge from hibernation in the spring. If this is not practical, turning the logs so that the sun will strike what was the under side, when the beetles deposited their eggs, will destroy the majority of the larvae. The beetles apparently prefer the logs at the outer edge of the piles, probably as they are the first ones reached, and are also less damp, so that turning over the bottom logs at the outer edges is decidedly worth while. In no case should the larvae be permitted to mature in the logs as this merely enhances and augments further infestations in the region.

BIBLIOGRAPHY OF ECONOMIC REFERENCES

Carter, E. E. 1916. *Hylobius pales* as a Factor in the Reproduction of Conifers in New England. Proc. Soc. Amer. Foresters, vol. ii, no. 3, pp. 297–307.

Felt, E. P. 1906. Insects Affecting Park and Woodland Trees. Mem. New York State Mus., No. 8, 2 vols., pp. 877.

Fitch, Asa. 1859. Fourth Report Noxious Insects of New York, p. 66. Albany.

Harris, T. 1841. Report on the Insects of Massachusetts Injurious to Vegetation, pp. 459. Cambridge, Mass.

Munroe, J W. 1914. A Braconid Parasite on the White Pine Weevil. (*Hylobius abietis*) Ann. app. Biol. vol. 1, pp. 170–176, 4 figs.

Packard, A. S. 1878. Guide to the Study of Insects, pp. 715. New York.

Packard, A. S. 1881. Insects Injurious to Forest and Shade Trees. Bull. U. S. Ent. Comm., No. 7, pp. 275.

Packard, A. S. 1890. Insects Injurious to Forest and Shade Trees. Fifth Rept. U. S. Ent. Comm., pp. 957.

Stevens, F. L. 1913. The Fungi which Cause Plant Disease, pp. 754, New York.

Thomas, Cyrus. 1880. Report on Noxious and Beneficial Insects of Illinois, Sixth Rept., pp. 174.

12

HARVARD FOREST

BULLETIN NO. 4

RICHARD T. FISHER, *Director*

RED OAK AND WHITE ASH

A STUDY OF GROWTH AND YIELD

BY

REUBEN T. PATTON

HARVARD FOREST, PETERSHAM, MASS.
1922

COPYRIGHT, 1922
HARVARD UNIVERSITY PRESS

CONTENTS

Succession of Types 5

Tree Form in the Final Stand 11

A. Diameter Growth 11

B. Interrelation of Diameter, Bole, and Crown 12

C. Relation of Width to Price 17

D. Average Widths and Values of Yields 19

E. The Final Objective 22

Yield Tables 24

A. Expansion of Crown 24

B. Yield Tables 34

Price Increment 38

RED OAK AND WHITE ASH

A STUDY OF GROWTH AND YIELD

SUCCESSION OF TYPES

THESE studies were carried out on the Harvard Forest and surrounding woodlands. The country here is physiographically simple and consists of wide open valleys running north and south. The bed rock is gneiss and this gives rise generally to a sandy or light soil, but heavier soils also occur. The forest is not original, but is practically all second growth.

Just prior to the Civil War, the farmers of central New England began to abandon their farms, partly on account of the opening up of the West, partly because of the growth of manufactures and later because of the Civil War. The ground was very stony and rough and the climate very bitter. No extensive cultivation was possible owing to the results of the glacial period. Boulders abound, particularly at the lower elevations, which normally are the most fertile. The higher elevations are the freest from stones, but they are also the most exposed. This had been a region of dense forests when first settled and the original homes bear witness of the magnificent trees which grew in those forests. As in every case of pioneer settlement, the rich stores of timber were swept away and this rock strewn, boulder-covered land was converted to farmland. This region is peculiar in that while the soil may be regarded as agricultural, the land as a whole, owing to the boulders, must be regarded as forest land.

Once abandoned, the land was at once attacked by the forces of nature. The lightest seeded trees, white pine and gray birch, seeded up the greatest part. It would appear from many fields at present that the longer an area is left unseeded the more difficult it becomes to establish tree growth

there. The soil appears to become more compacted and resistant to seed. Even gray birch, perhaps the most prolific seeder, makes slow headway on these old treeless fields. While white pine has been the most fruitful source of reafforestation, a few fields were given back to oak, ash, and other hardwoods. Although white pine has reclothed these abandoned lands with dense stands yet to-day beneath these pines there is an abundant advance growth of all kinds of hardwoods, but particularly red oak, white ash, and red maple. These, in the seedling stage, are quite tolerant of shade and are growing freely, although the growth is much slower than in the open. The striking feature is the absence of pine in this advance growth.

We have here a replacement going on, one step towards a reversion to the original highly mixed forest. This replacement or succession is due to four factors. In the first place, the site is as good a hardwood site as it is a white pine site. The original forest was mixed hardwood with scattering pine. Secondly, the pine has formed a suitable seed bed for hardwoods. It is probable that the absence of a seed bed, equally as much as the weight of the seed, prevented the hardwoods, such as oak, chestnut, and beech, from occupying the vacant lands. An examination of germinating acorns, scattered around under a parent tree, will show that those that have lain on the surface of the ground have, in the majority of cases, damaged or decayed radicles. Under the pines the seed, aided by the agency of small animals, becomes imbedded in the litter of the forest floor and is here protected. Generally speaking, the smaller a seed, the better is its chance of forming a tree. Size of seed is as important as weight.

How successfully the pine prepared the way for the hardwoods is shown by the following example. Along an old stone fence which runs north and south there stands a row of immense old trees whose diameters are given in the following table:

TABLE I

Species	D.B.H. Inches	
Red Oak (2)	30.4	43.5
Chestnut (2)	26.0	29.8
Ash	26.4	
Basswood	26.4	
Sugar Maple	23.1	
Yellow Birch	15.7	

It is most probable that these trees were mature and bearing seed when the surrounding fields were abandoned. To the west of the fence and the row of old trees was formerly an abandoned field which grew up completely to pine. This stand was cut off a few years ago and to-day the field is completely covered with hardwoods. There are no pines in the young stand, although there are mature pines in the surrounding areas. As the prevailing winds are northwest and southwest, the seeding up of the field by the row of old hardwoods was distinctly at a disadvantage both formerly and at the present. The following table gives some idea of the composition of the young stand which is thirteen years old. The plot used for the estimation of the composition was one-twelfth of an acre and the number of trees per acre averaged 3800.

TABLE II

Species	Percent of Mixture
Ash	57
Sugar Maple	20
Red Oak	8
Gray Birch	4
Red Maple	3
Black Birch	2
Yellow Birch	2
Pin Cherry	2
Basswood	1
Miscellaneous	1

The third factor influencing this succession is the intolerance of shade shown by the pine. It has been clearly shown on the Harvard Forest that by suitable fellings a reproduc-

tion of pine up to 40,000 trees per acre can be secured. But light is necessary. In the natural stand itself, whatever pine seedlings there may be, are very stunted. On the other hand, there is usually an abundant advance growth of hardwood, as the following table will show. The plot used for the enumeration of the advance growth was .2 acre. The mature stand was pure pine, seventy years old, and averaged 300 trees per acre.

TABLE III

Species	Percent of Mixture
Red Maple	36
Red Oak	12
White Oak	12
Black Birch	12
Chestnut	10
Black Cherry	9
White Ash	6
Gray Birch	1
Poplar	1
Miscellaneous	1

The number of stems per acre of this advance growth averaged 2,600 and only stems over a foot in height were taken. In this particular area red maple is seeding in very freely. Plots ten feet square were used to count the number of red maples from one foot in height downwards. The greatest number recorded for one of these plots was 130, which is equivalent to 56,000 per acre.

Gray birch, which so freely seeds up vacant areas, does not occur at all freely in this advance growth under pine. This is due to its demands for light. In this respect it stands away from the other hardwoods and closely approaches pine. Gray birch is practically a useless tree but a vigorous grower. Where the birch has occurred in quantity in cut-over land, this has been due to lack of density of the advance growth. The birch has seeded in after the cutting of the pine, and has gained a foothold in the vacant spaces. Adequately stocked land will not be attacked by gray birch. It may be here remarked that no such thing as an average can be given for the

composition of this advance growth. There are over twenty species of hardwoods occurring here. Each pine stand has its own characteristic advance growth.

The fourth factor influencing this reversion is the slow growth of pine in its early years. When the pine stand is logged all the hardwood advance growth is cut down. In the following spring the seedling and sapling stumps give forth vigorous shoots so that any pine seed which may have fallen the previous autumn germinates under a more or less dense shade. Red oak appears to have the least vigor in growth for the first year after the pine has been removed. The measurement of 330 oaks at the end of the first growing season after removing the pines gave the following results:

TABLE IV

Height — Inches	Percentage
0–10	54.9
10–20	31.5
20–30	11.2
30–40	2.1
40–50	0.0
50–60	0.3
	100%

Ash has a very vigorous growth in its early years, and in Table V is given a comparison in height growth of ash, oak, and pine for the first ten years. The areas from which the measurements were taken were close to one another and were originally covered with almost pure pine.

TABLE V

Age in Years	Height in Feet		
	Ash	Oak	Pine
1	1.5	.7	.1
2	3.0	1.6	.2
3	4.9	2.7	.3
4	6.5	4.0	.5
5	8.1	5.4	1.0
6	9.9	6.7	2.0
7	11.7	8.1	3.2
8	13.7	10.4	4.6
9	15.6	13.3	6.2
10	17.9	16.1	7.8

Although the pine type is reverting to hardwood, the incoming stands are not in themselves final. It would appear that mature hardwood stands do not provide such a good seed bed for their own seed as do the pine stands, and hence the advance growth under hardwoods is not so dense. This probably makes possible the reintroduction of the pine. The climax forest of the region is one of mixed pine and hardwoods with an understory of many species for the better sites.

The question of the yield of unmanaged second growth hardwood stands has been fully considered and the results are given in Harvard Forest Bulletin No. 2, "Growth Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England," by J. Nelson Spaeth. Since in these stands, arising from the cutting of both pine and hardwood, the most valuable trees are oak and ash and, also, since a great percentage of the young growth consists of these two trees, it is obvious that the forest of the next rotation will be largely an oak-ash stand. This type is now fully recognized by the silvicultural policy on the Harvard Forest, partly because of the great value of these two species and partly because of the prohibitive cost of reconstituting pine stands on the better soils. As these forests are situated in a region of wood-using industries where practically every load of lumber can be sold, as well as cordwood, they can be placed under intensive management. This has already been begun on the Harvard Forest, and the purpose of the present study was to obtain data for the purposes of future management. The specific questions for determination were, therefore, rotation and density as related to growth, tree form, and value of yield.

TREE FORM IN THE FINAL STAND

A. Diameter Growth

In studying the growth and development of oak and ash stump analyses of oak and ash were first made. These stumps were of trees which had produced the highest grade lumber in the district. They were of an age mainly between sixty and seventy years, with a few running up to seventy-five years. All the subsequent data were collected on sites similar to those on which the stumps occurred. The ages of the stands were similar to those of the stumps. No data were obtained for ages above seventy-five years. This was because the stands become merchantable at about seventy years and are felled at or about that age. So far, then, as local practice goes, seventy years may be regarded as the usual rotation.

Stump taper curves were made from neighboring trees and from these curves the diameter at breast high of the various stumps determined. The amount of growth in diameter for each diameter class was also ascertained.

Figure 1 gives the results of the examination of forty-two oak stumps and twenty-three ash stumps. The curves are for wood only and show some very characteristic features. In the early years, the growth of ash is much faster than that of oak. These forests have arisen mainly as sprouts from small advance growth, and hence the growth is much greater than would be the case if the tree originated from seed. Ash grows better under shade than does oak, and hence forms a better root system for the subsequent sprouts. The size of the sprouts is directly governed by the root system of the advance growth and the size of the latter is largely a question of age.

The main feature of the graphs is, however, the course of the curves at the seventieth year. Oak is still growing vigorously and is producing wood at the rate of .2″ a year, or for ten years two inches of diameter. Ash, on the other hand, is only producing wood at the rate of one inch for every ten

years. Many ash trees have twenty-five rings to the last inch. This is very characteristic of ash and is due to its capacity to endure congestion or crowding of the crown. Oak, on the other hand, demands space. For these characteristics we require new terms. We might say that oak is space demanding, while ash is crowd enduring.

Since, however, increase of diameter is closely associated with clear length of bole and crown development, these two latter factors must be studied before it can be ascertained how far this rapid increase of diameter of oak can be maintained and how far the slow growth of ash may be avoided. The curves for diameter growth are in no way final in themselves since they are in no way correlated with clear bole or radius of crown. All that they do show is the characteristic type of diameter growth of each. Oak shows a desirable diameter growth while ash shows in its latter years very undesirable growth.

B. Interrelation of Diameter, Bole, and Crown

An examination was next made of the dominant trees in the age class sixty to seventy years, and for each tree the height, length of clear bole, diameter breast high and radius of crown were taken. In measuring the crown four radii were taken and the mean calculated. The measurements were repeated later on a number of the same trees, other radii being used, and it was found that the differences resulting were small and could be neglected. Trees having very irregular crowns were rejected.

The term clear bole was taken to mean the length to any branch, dead or alive, beyond which there was not a clear log length. This gives correct results so far as the uncultivated forest is concerned, but it does not correctly indicate the length of clear bole obtainable under systematic control. However, it has been retained as introducing a conservative element into the conclusions. This will be referred to again.

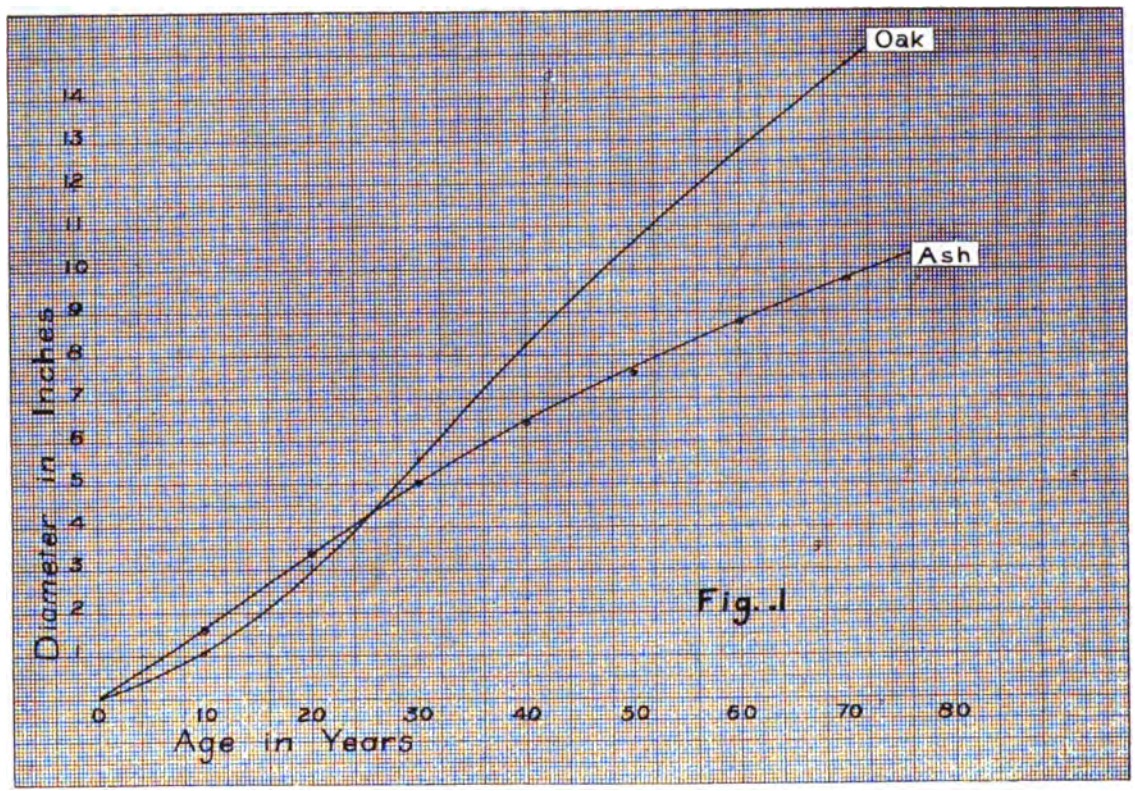

Oak
Ash
Diameter in Inches
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
10
20
30
40
50
60
70
80
Age in Years

Fig. 1

In the following table are given the results for ash. The trees are grouped by one-inch diameter classes. The figures given are the actual averages obtained in the field.

TABLE VI. ASH

D.B.H. Inches	Height in Feet	Bole in Feet	Crown Radius in Feet	Equivalent Trees per Acre
7.0	72	47	5.5	459
8.1	74	46	6.0	385
9.0	79	47	6.6	318
10.1	79	45	7.1	275
10.9	82	48	7.7	234
12.0	80	44	8.7	183
13.1	80	44	10.0	139
Basis	109 trees.	Age 60—70 years.		

It will be seen that though the spacing of the trees as given by the crowns amounts to a difference of nearly one hundred per cent yet the total height averages about the same for all classes, except the first two. This implies that up to a certain point, at all events, closeness or openness of the stand does not affect height growth.

The average length of clear bole in all is comparable. This length averages around forty-five feet but in a managed forest it could be taken at fifty feet, or even at fifty-five feet. Ash trees felled on Harvard Forest, from 8″ to 12″ in diameter have given a clear length of sixty feet. That the average length of clear bole is practically the same for all the crown radii given is important since it indicates that the limit of thinning an adequately stocked young forest of ash has not yet been reached; or, in other words, a system of thinning which would produce these results is not severe enough to retard natural pruning. Each row of figures in the preceding table represents a possible end point at seventy years for any system of progressive thinning. Which is the best, however, must be settled by the objective of the forester. In general, this objective is the greatest money return. The financial yield is itself governed by the total yield and value of that yield.

In Table VII is given the board foot content per acre for an ideal stand of each diameter class. The bole has been taken at forty-five feet and all the trees have been assumed to have the same taper.

TABLE VII. ASH

D.B.H.	Yield per Acre Board Feet
8.0	29,300
9.0	27,400
10.0	25,400
11.0	24,700
12.0	24,400
13.0	23,200

The yield decreases with increasing diameter of stem. In the table we have not considered cordwood, which would increase the yields of the larger diameter classes. This, however, need not be considered as the volume of the wood involved is slight and the aim of the investigation was to ascertain the greatest financial return from saw timber.

Before considering the ash further, the results for oak will be given. It has already been mentioned that ash differs materially from oak when grown in high forest. This is fully borne out by a consideration of Table VIII, which gives for oak the relations between diameter, height, clear bole, and crown radius.

TABLE VIII. OAK

D.B.H.	Height in Feet	Bole in Feet	Crown Radius in Feet	Equivalent Trees per Acre
11.2	78	40	8.8	179
12.1	80	38	9.7	147
13.0	82	37	10.6	123
14.0	81	34	11.4	107
15.0	83	33	12.5	89
16.0	84	31	13.6	75
17.1	83	29	14.8	63
17.9	84	28	15.5	58
19.0	83	27	16.6	50
20.0	83	22	17.5	45

Basis 193 trees. Age 60–70 years.

With two exceptions, the figures are the actual averages obtained for each diameter class. This table shows that there is a much greater variation in the case of oak than is the case with ash. Yet both species occur together in the same stand. Oak demands space and struggles to obtain it. Its lower branches persist much longer than do those of ash, and this despite the fact that ash appears to be much more tolerant of shade in the seedling stage. Oak will maintain a lower branch and thrust it out towards a source of light where ash would sacrifice the branch.

Oak is similar to ash in that the height growth is not affected by the density of the stand. This is true, of course, only within certain limits; but so far as the tables given go those limits have not yet been reached.

While total height is not affected by the degree of spacing, the length of clear bole is seriously decreased by the wider spacing. It will be seen that there is a gradual decrease in length of clear bole with increase of crown radius. When the crown canopy closes the lower branches are killed, and it comes about where the density was small in the early years that there is a big difference between length of clear bole and length to first living branch. In the larger diameter classes length of clear bole and length to first living branch usually coincide. This will be dealt with later when the trees will be grouped under bole classes of different lengths.

In Table IX is given the yield per acre for an ideal stand of each diameter class given in the last table. The yields are taken from mill tally studies made on the Harvard Forest. The clear bole has been divided into the standard log lengths of the district eight, ten, and twelve feet and the board feet contents have been read from the log tables.

TABLE IX. OAK

D.B.H. Inches	Board Feet Per Acre
11	23,000
12	19,100
13	17,700
14	16,400
15	15,700
16	14,900
17	13,400
18	13,100
19	11,650
20	10,750

As in the case of ash, the yield steadily decreases with increasing diameter of stem. But yield is not the only factor, for the lumber from the different diameter classes has different values and before discussing the value of the yield, the variation in price according to the average width of board will be considered.

C. Relation of Width to Price

It is well enough known that the narrower the board used in any particular industry, the greater the percentage of waste. Hence, it is to be expected that the value will bear some relation to the percentage of useable lumber in a board. The percentage of waste rapidly decreases as the boards increase in width until, above a certain width, the difference in the amount of loss is negligible. Hence, with wide boards the value ought not to change.

In local hardwood using industries, this was found to be the case and prices were obtained for oak from both chair manufacturers and wholesale dealers. It was found impossible to get a series of values for ash, partly because it is not greatly used locally and partly because it is used in certain specific industries where only particular qualities or sizes are required, such as tennis rackets, baseball bats, oars, motor cars, airplanes, etc. On account of its use for these special purposes higher prices are paid for ash than for oak. Oak, on

the other hand, is used locally in large quantities and in all sizes. In the chair industry where most of the red oak is consumed the logs are sawn into plank 2″ to 4″ thick, round edge. For first quality, the timber must be practically clear, free from defects and straight in grain. Width of ring, or, in other words, whether the timber be fast or slow grown, is of no importance and does not affect price. In an examination of lumber piles, the widest rings seen in oak were half an inch. The source of this lumber was not known, except that it was not obtained in New England. In the various operations in the factories, such as turning, bending or polishing, width of ring was of no importance. This is not the case with ash, for width of ring is an important factor in certain industries. These, however, were not investigated. The highest price paid for oak is for plank averaging about 10″ and upwards in width. Wide planks are not favored owing to the greater difficulty of handling them. The smallest average width for which a price was quoted was six inches, and the price paid for this ranges from about fifty-three per cent to sixty-three per cent of the price of the 10″ lumber. There is an abrupt rise to the price of 7″, and each succeeding rise is less as the limiting value is reached. If we consider the highest price paid as one hundred per cent, the prices of the various sizes would be as in the following table:

Average Width	Percentage of Highest Price	Approximate Fraction Value
10	100	1
9	97–95	1
8	92–89	9/10
7	82–77	8/10
6.5	68–60	7/10–6/10
6.0	62–53	6/10–5/10
5.5	34–18	3/10–2/10
5.0	22–5	2/10–1/20

The percentage values of 5 and 5.5 inch lumber have been calculated from the prices obtained. It would appear from this that timber averaging five inches in width, if used in the same industry as the wider material, has very little value.

Timber averaging four inches would have no value in the same industry.

It will be observed that prices rise for each inch class by gradually decreasing increments and proceed to a limiting value. The increases in value when the boards become wide are very small, and are neglected commercially. The law underlying the increases in value appears to be that the increment in value from one inch class to another is approximately a definite fraction of the difference between the value of the lower class and the maximum or limiting value. This fraction appears to be about one-half. For example, if the maximum value of oak is $60 a thousand, and the price of six-inch be $40 then the value of the seven-inch would be $50 a thousand.

D. Average Widths and Values of Yields

Since increase of the average width of the lumber is the important factor in value, it is of interest to know what average width of $2\frac{1}{8}''$ plank each diameter class of tree will produce. In Table XI is given the average width of ash lumber sawn $2\frac{1}{8}''$ with $1\frac{1}{8}''$ sidings.

Locally, all good grade lumber is cut into planks with a thickness of $2''$ and over. The $2\frac{1}{8}''$ is surveyed as $2''$ and the $1\frac{1}{8}''$ sidings as $1''$. For thickness $2''$ and over the price does not vary.

TABLE XI. ASH

D.B.H. Inches	Av. Width of $2\frac{1}{8}''$	Board Feet Per Acre
8	4.9	28,600
9	5.5	26,800
10	6.1	23,600
11	6.7	24,000
12	7.3	22,400
13	7.9	22,100

The board feet per acre include the sidings and the percentage of sidings increases with decrease in the diameter of the log. As it was found impossible to obtain a series of

prices for ash for the various average widths of the lumber, the fractional values given for oak in Table X have been used. These have been multiplied by the board feet per acre to obtain what has been called the relative value per acre. The yield per acre is considered as consisting wholly of 2″ plank.

The results are given in Table XII.

TABLE XII. ASH

D.B.H. Inches	Fractional Value	Board Feet Per Acre	Relative Value Per Acre
8	1/5	28,600	5,720
9	3/10	26,800	8,040
10	3/5	23,600	14,160
11	3/5	24,000	14,400
12	4/5	22,400	17,920
13	9/10	22,100	19,890

The largest diameter class has the greatest relative value, and the relative value increases from the smaller diameter classes upwards. From Table XII it is apparent that the most profitable diameter class to produce is the largest. The number of trees having a diameter of 13″ at seventy years was very small and, therefore, it is at present doubtful if that diameter could be generally produced at that age. The 12″ class is frequent and, therefore, we may at present consider this to be the ideal diameter to be produced in seventy years.

In Table XIII is given the average width of lumber from the oak according to lengths of bole and diameters given in Table VIII.

TABLE XIII. OAK

D.B.H.	Av. Width 2½″ Plank	Yield Per Acre Board Feet
11	6.4	23,000
12	7.3	19,100
13	8.1	17,700
14	8.8	16,400
15	9.5	15,700
16	10.2	14,900
17	10.9	13,400
18	11.5	13,100
19	12.1	11,650
20	12.7	10,700

Since the maximum price is paid for ten-inch lumber and since all stands of diameter classes from sixteen inches onwards have an average width of 10″ and over and produce progressively less lumber per acre, there is no need to consider these further. The larger diameter trees could not be considered in any controlled forest, since, in order to obtain a large diameter, length of bole would have to be sacrificed. In these larger trees, as has already been mentioned, the top of the bole ends at the first living branch. Therefore, the large diameter could not be secured with a longer bole in a rotation of seventy years. There is another consideration, and this is that these larger trees are seventy years of age or slightly over, while the smaller diameter classes are about sixty-five years. However, for the present all are being considered as of the same age.

In Table XIV is given the total value per acre of a stand of the various diameter classes. The amount of 1½″ sidings is taken from local mill practice. The prices given for the average width have been averaged from actual prices obtained. The limits are actual ruling prices.

TABLE XIV. OAK

D.B.H. Inches	Av. Width 2½″ Plank	Board Ft. Per Acre	Yield 2½″	Price M. Ft. $	Value $	Yield 1½″	Price M. Ft. $	Value $	Total Value $
11	6.4	23 000	19,550	36	704	3450	25	86	790
12	7.3	19,100	16,235	46	747	2865	"	72	819
13	8.1	17,700	15,050	51	768	2650	"	66	834
14	8.8	16,400	14,760	53.5	790	1640	30	49	839
15	9.5	15,700	14,130	55	777	1570	"	47	824
16	10.2	14,900	13,410	55	738	1490	"	45	783

The average width of lumber from the 15″ class was 9.54 and, therefore, the price given to this class was the maximum. The highest return comes from the 14″ class, followed closely by the 13″; but there is, on the whole, not much difference between the total values.

The length of bole of the 14″ class was thirty-four feet, but it is to be expected that under systematic management the forest will be able to produce a much longer bole than this.

E. The Final Objective

From the previous discussion of ash, it was seen that the greatest diameter class gives the greatest return. However, since the 13″ class in ash was not frequently found, it is as yet doubtful if this diameter can generally be produced in seventy years. The next class, the 12″, is abundant. The age of this class was between sixty-five and seventy years. Sample trees which were felled showed that a diameter of 11.6″ was produced in sixty-five years. At the same rate of growth occurring during the previous five years, a diameter of 12.4″ would be produced in seventy years. These sample trees had clear boles of fifty-five feet. In Table VI the 12″ diameter was associated with a crown radius of 8.7. From a graph of crown radii against diameters of stem we find that a diameter of 12.4″ would be associated with a crown radius of 9.1 feet.

We may say then that the trees of the final harvest of ash at seventy years would average 12.4″ diameter, 9.1 feet crown, fifty feet bole, and a height of eighty-two feet.

In the case of oak where the bole gradually decreases with increasing diameter, the difference between clear length of bole and length of trunk to first living branch is very great, especially in the medium diameter classes. In ash this difference is small. Hence in oak with each diameter class there is a great variation in length of bole, and this variation diminishes as diameter increases. That portion of the bole which bears dead branches could be greatly reduced if the forest were adequately stocked in its early life.

Boles fifty feet in length occur, and this is the desirable length. The largest clear bole found in oak was fifty-four feet, while the longest in ash was sixty-eight feet. It may be said in passing that if a clean bole of fifty feet can be obtained on a ten-inch tree it can be secured for the higher diameters and later years.

If the trees in Table VIII be grouped by length of clear bole we get the results given in Table XV.

TABLE XV. OAK

Bole Feet	Diameter Inches	Crown Radius Feet
50	13.4	10.4
45	13.6	11.0
40	13.8	11.3
35	13.9	12.0

It will be observed that the 11″ and 12″ diameters have become merged into the 13″ and 14″ classes. It will be noticed also that while the difference between the diameters amount to 3.7 per cent, the difference in crown radii amounts to 15.4 per cent. Within narrow limits each diameter can be produced by different sized crowns. Generally, however, the larger crown is associated, as in the table, with a shorter bole. The extra energy developed by the larger crown is used up in forming branch wood.

Sample trees with boles above forty-five feet which were felled as well as the stump analyses showed that a diameter of 13.4 to 14.9 was produced in sixty-five years. At the rate of growth occurring in the 13.4″ tree during the decade prior to felling, a diameter of 15″ would be produced in seventy years. It was found, by the method to be discussed in the next section, that a crown of 11.2 feet radius would be associated with a fifteen-inch diameter and fifty-foot bole. In the 15″ diameter class the longest clean bole was forty-nine feet and was associated with a crown radius of only nine feet. The average for the class was 12.5 feet, so that the radius 11.2 feet is well within the lower limit of the range found in nature. It may be again stated that in each diameter class the longest boles are associated with the smallest crown radii. The final harvest of oak then will consist of trees averaging, at seventy years, 15″ in diameter, fifty feet bole, 11.2 feet crown, and a height of eighty-five feet. A tree of these dimensions will produce an average width of 9.1′ for 2″ plank.

Having selected the type of tree that is to form the final harvest, the question arises as to how to treat these areas, which have reverted to hardwood, so as to produce the de-

sired crop. This is primarily a matter of the proper control of the density throughout the life of the stand. There was an abundance of material for study below twenty years and above sixty years, but there was rather a scarcity of material between these ages. It was, therefore, necessary to follow in part some other line of study in order that the deficiency might be overcome. It was decided to make a study of crown development both from living material and from existing yield tables. If the area of the ideal crown for any age be known, then the corresponding number of trees per acre could be found, and thus a criterion established for periodic thinnings.

YIELD TABLES

A. Expansion of Crown

It has been noticed in Tables VI and VIII that stem diameter is a function of crown radius. In general, the larger the crown the larger the diameter of the stem. Growth of crown is essentially different from either height growth or diameter growth. We have already seen that within at least certain wide limits growth in height is not affected by the density of the stand. For the variations in density in ordinary forest practice, height growth may be said to be beyond the control of the forester. Diameter, however, being a function of the crown radius, may be varied by varying the crown radius, or, in other words, by varying the density of the stand. This latter is secured by various degrees of thinning.

With open grown trees height growth, diameter growth and crown growth follow much the same curves of growth. If we consider an open grown oak or pine, the longest branches are very low down and may even rest on the ground. Pine branches are easy to study and these show that the expansion of the crown is at first very slow, then very rapid for a few years, and then after this rapid growth there is a very gradual decline. This is precisely the same type of growth as for height and diameter.

In a forest, however, crown growth is entirely different from other forms of growth, and may be put into a class by itself. In the forest the crown is engaged in a struggle for existence; it is constantly surrounded by forces opposing its development, while both height and diameter are free. The crown has either to overcome or be overcome, to win or to be subdued. If we consider pine for the sake of simplicity, we find that the attack by the crown is carried on and maintained in intensity by reinforcements in the form of new branches. In both height and diameter development, the new additions are always placed upon the old, but in the crown struggle new units are constantly being added and the old ones pass to their death. In the open grown specimen the position of the crown is fixed, but in the forest tree the crown moves up the stem. Since the growth of the crown then is constantly impeded and resisted, it is to be expected that its curve of growth will differ materially from that of diameter or height. Since all forests, no matter what their composition, are engaged in the same struggle, it is not unreasonable to expect that some common law holds for the development of the crown. Naturally, development of the crown means the constant elimination of trees and the lessening of the density. Although all engage in this struggle, it does not say that all trees engage in it with the same intensity. It has already been noted that oak is space demanding, while ash is crowd enduring. The feebleness of the struggle carried on by ash is reflected in the decrease of the rate of diameter growth as already mentioned. White pine seems to stand midway between those two trees. From a study of the crowns of various species, it was assumed that the expansion of the crown was a linear function of time. To see how far this might be true an examination of a very large number of European yield tables was made and the crown radius determined for each decade. In the calculation the crown has been assumed to be circular. Figures 2, 3, 4 give the radii of the various crowns plotted against time. Figure 2 is taken from Grave's *Mensura-*

tion. Figure 3 is taken from *The Reports of the Swedish Institute of Experimental Forestry*, 1916–17. Figure 4 is from the *Allgemeine Forst und Jadg Zeitung*, vol. 84, p. 266.

Only one graph in those given is a distinct curve. Many crown graphs are distinct curves. Yet the majority show a straight line. In many the curve is so slight as to be approximately a straight line. This is the case in each of the three site qualities given by Fleury in *Ertragstafeln für die Fichte und Buche der Schweiz*, Zurich, 1907, and also in the four site qualities given by Wimmenauer for oak in *Allgemeine Forst und Jadg Zeitung*, vol. 89, p. 261. Slight curves might also be drawn in Figures 2, 3, and 4.

Since the expansion of the crown can be represented by a straight line, it follows that the crown growth is a linear function of time. Before applying this law to the data given for oak and ash it is as well to consider the equation for the the straight line. The statement that the expansion of the crown is a linear function of time refers only to the period of time covered by the average rotation. The general equation for the straight line is:

$$r = b + mt \quad \ldots\ldots\ldots\ldots \quad (1)$$

where r = radius of the crown in feet
b = intercept on the axis of r
m = tangent which the graph makes with the t axis
t = time in years

Now b may be either positive or negative. If b be positive it implies either that there was already a crown existing when the forest commenced or else that the greatest period of growth was in its earliest years. In the latter case the curve of expansion would be convex upwards until the straight line was reached. Neither assumption is true; and, therefore, b cannot be positive. Such graphs arise through the stand being either insufficiently stocked in its early life or else through its being too congested later in life. In white pine stands, both factors are operating and from most stands a

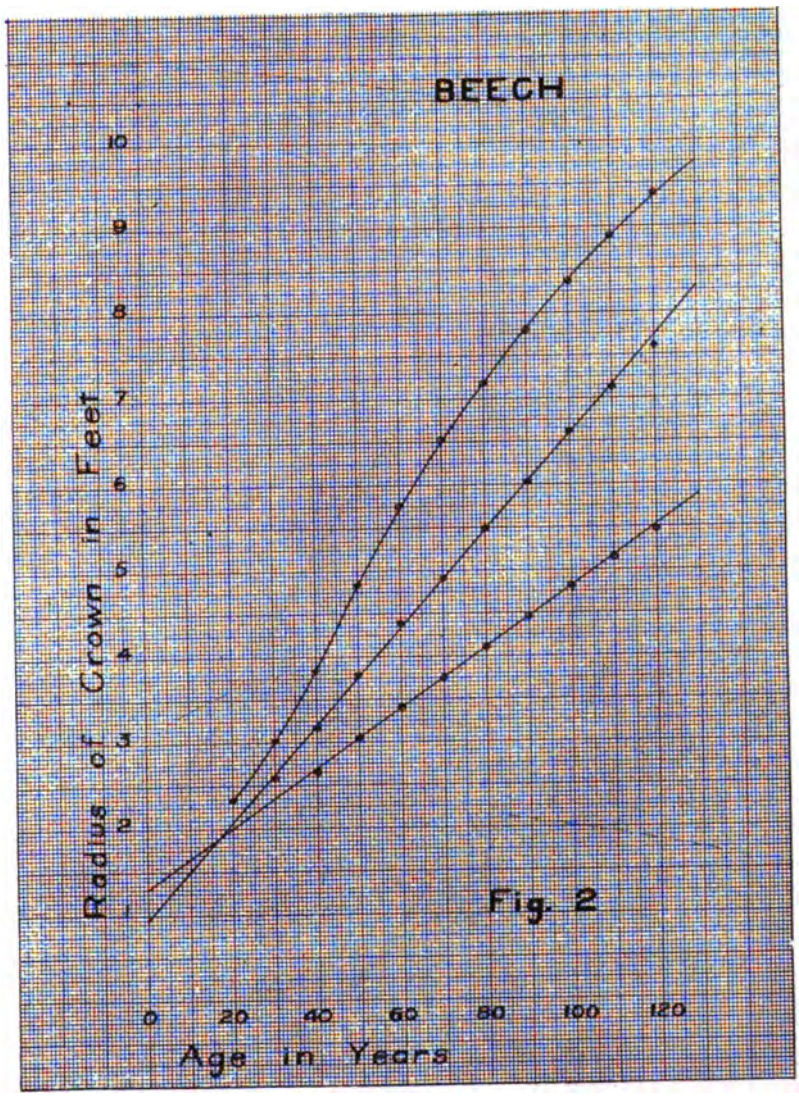

BEECH
Radius of Crown in Feet
10
9
8
7
6
5
4
3
2
1
0
20
40
60
80
100
120
Age in Years

Fig. 2

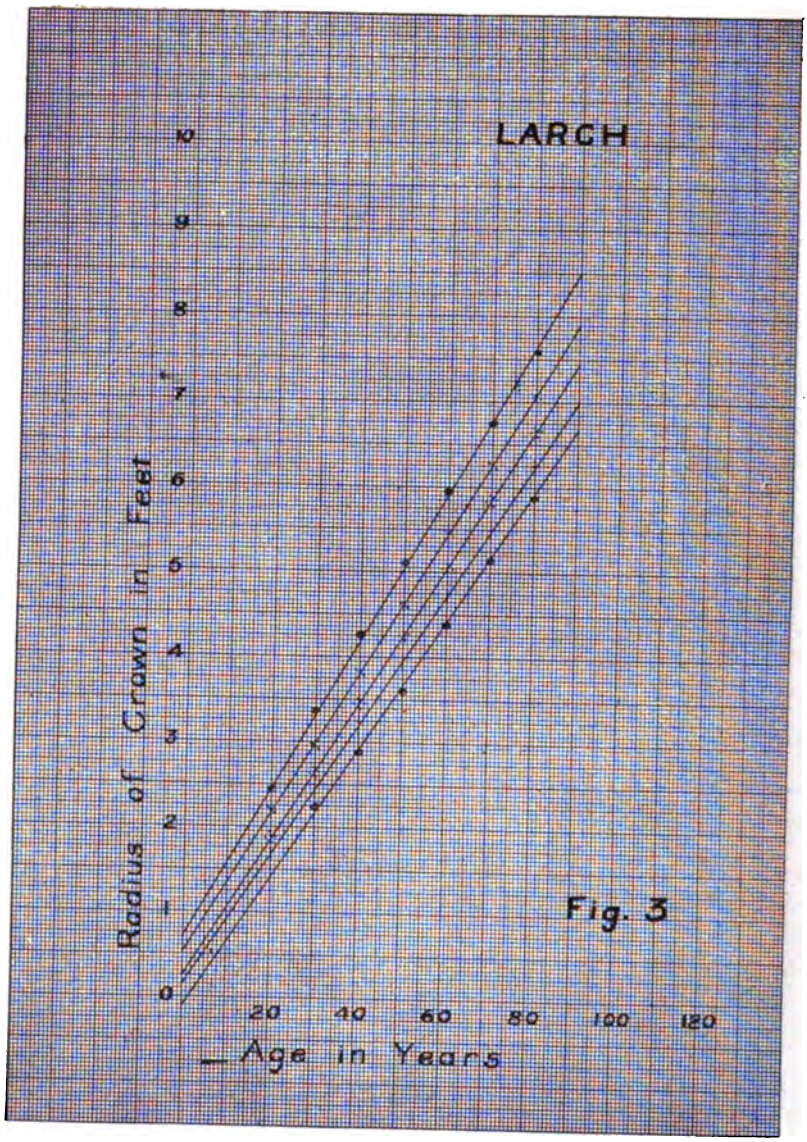

LARCH
Radius of Crown in Feet
0
1
2
3
4
5
6
7
8
9
10
20
40
60
80
100
120
Age in Years

Fig. 3

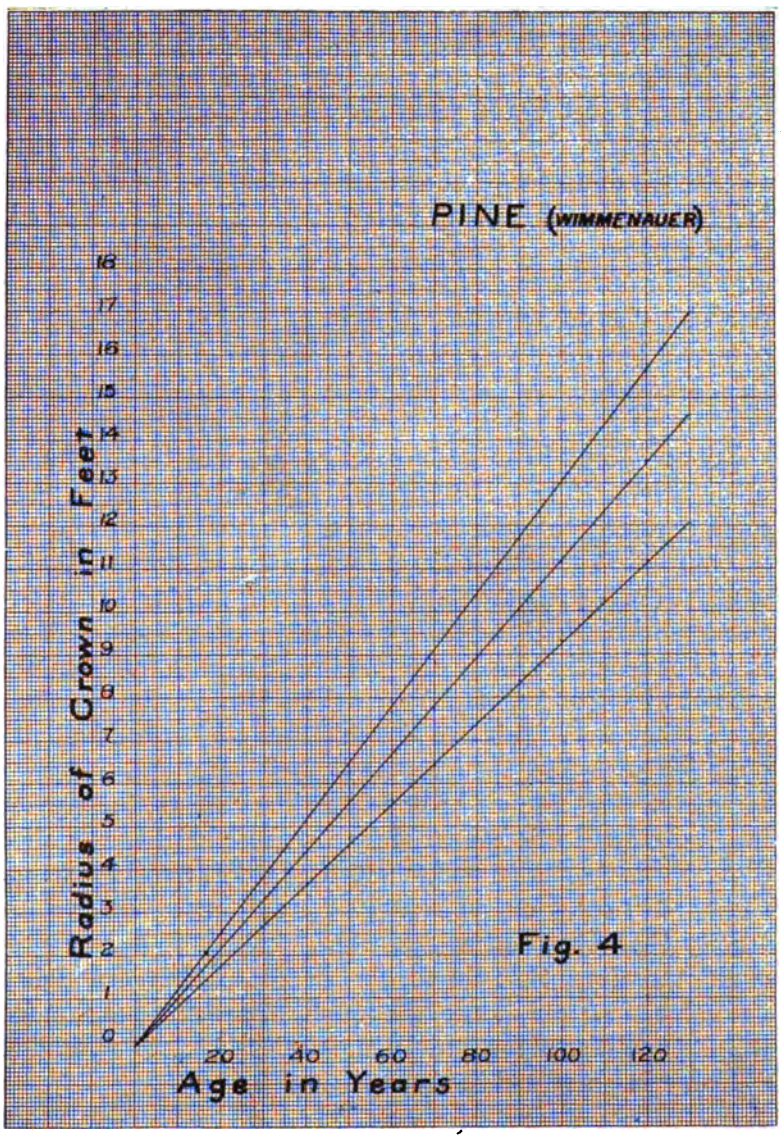

PINE (WIMMENAUER)
Radius of Crown in Feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
20
40
60
80
100
120
Age in Years

Fig. 4

graph would be obtained cutting the vertical axis above the origin. It may be here remarked that the congestion of the crown canopy at the later periods of the forest's life may so restrict the crowns that any thinning experiments carried out on such a forest would yield negative results. As has been shown already, the smaller the crown for any given age, the smaller the diameter. The smaller the diameter for any given height the less the rigidity of the stem. The thin stemmed, small crowned trees sway in the wind and their crowns rub off all the lateral buds from their own and the neighboring crowns. This occurs particularly in ash and pine. Such trees cannot respond actively, if at all, if the stand be thinned. A tree does not differ from any other biological unit and can only respond to a stimulus when kept in a condition to do so.

For any graph b cannot be positive, but may be either zero or negative. If zero it assumes that crown expansion proceeds regularly through the life of the stand. If b is negative, it implies that growth at the early period was slow and that a concave curve joins the straight line to the origin. In all four site qualities of oak as given by Wimmenauer b is negative. It will be seen that in the case of larch, Figure 3, the m values are not widely different. In some sets of graphs the m values are all the same. This would imply that the trees on all site qualities carried on the struggle for existence with the same intensity. This cannot be considered as correct, for since a lower site quality is indicated by a smaller height, a smaller diameter and a smaller volume, it follows that trees on a lower site quality carry on the struggle for existence with less intensity than those on a higher site quality. We may conclude, therefore, that the higher the site quality the higher the value of m; and, hence, the graphs of crown expansion for the site qualities of any particular species will not be parallel.

Now r is connected in the equation

$$\pi r^2 n = A$$

When n = number of trees per acre
and A = acre in square feet

Substituting for r in (1) we have

$$\sqrt{\frac{A}{\pi n}} = b+mt \ . \ . \ .$$

which gives

$$n\ (b+mt)^2 = \frac{A}{\pi} \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (2)$$

If b be zero, then the equation simplifies into

$$nt^2 = \frac{A}{m^2\pi}$$

Since A and π are constants and m is also a constant for any one species on any one site we may replace the right hand member of the equation by the constant C.

Hence we have

$$nt^2 = C \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (3)$$

This last equation says that the number of trees at any time multiplied by the square of the time gives a constant value. The simplified formula closely agrees with Wimmenauer's now celebrated Scotch pine experiments.

If the expansion of the crown be a linear function of time, then if any two points of the graph are known, the graph itself is known. From such a graph the number of trees per acre for any given year can readily be calculated by dividing the area of a single crown in square feet into the number of square feet in an acre. If, however, the graph passes through the origin then a good deal of calculation may be saved by merely calculating the trees per acre for any one year and then using formula (3) for the other years.

For both oak and ash two points on the graph of the crown expansion were obtained. From young stands, presumably fully stocked, the following dimensions have been taken:

TABLE XVI

Species	D.B.H. Inches	Height Feet	Crown Radius Feet
Oak	1.2	18	1.4
Ash	1.2	16	1.2

It has already been mentioned that the final objectives for oak and ash at seventy years are as follows:

TABLE XVII

Species	D.B.H. Inches	Height Feet	Bole Feet	Crown Radius Feet
Oak	15.0	85	50	11.2
Ash	12.4	82	50	9.1

From stumps whose diameters at breast high were within an inch of the expected or ideal final diameter, the curves of diameter growth for both oak and ash were obtained. From these curves the diameters and heights, falling between the limits given in the two preceding tables, were taken. From felled sample trees the curves of height growth were obtained similarly.

The tabulated results were as follows:

TABLE XVIII

Age in Years	Ash		Oak	
	D.B.H. Inches	Height Feet	D.B.H. Inches	Height Feet
10	1.2	18	1.2	16
20	2.7	36	2.7	37
30	4.8	53	4.5	57
40	7.0	68	6.8	68
50	8.8	77	9.5	75
60	10.6	81	12.2	81
70	12.4	82	15.0	85

In the case of ash, if on the graph we join the point 9.1 feet, crown radius at seventy years, with the origin, it would give a crown radius of 1.3 at ten years. This agrees closely enough with the radius in Table XVI, which was 1.2 feet. Taking the value 1.3 feet for ten years, this would give a radius of 3.9 at thirty years. Two stands of this age were examined and the results are given in Table XIX.

TABLE XIX. ASH

D.B.H. Inches	Height Feet	Bole Feet	Crown Radius Feet
4.8	55	31	4.1
4.9	52	29	3.9

Both of these agree with the diameter and height of Table XVIII for thirty years. Hence, we may assume that the calculated crown radius of 3.9 is the correct one for thirty years.

Measurements in a stand of from fifty to fifty-five years gave a crown radius 6.8. This latter would be correct for fifty-two years. The average height of seventy-three is fairly comparable with that given in Table XVIII.

In the case of oak if we join the point 11.2 feet at seventy years to the origin we get a crown radius of 1.6 feet at ten years. There is not very much difference between this and the computed 1.4 feet. However, oak stands need to be kept dense in order to prevent as much as possible the large development of side branches. The graph connecting the points 11.2 feet at seventy years and 1.4 at ten years will put the r axis below the origin.

A stand forty-three years of age with good boles and well formed crowns showed an average diameter of 7.1 inches and an average height of fifty-nine. The crown radius was 6.7 feet. While diameter and crown development agree generally with the computed measurements for oak on the better sites, the height is considerably lower and, therefore, the site may be considered to be inferior to those from which the measurements in Table VIII were obtained.

A stand whose age was from fifty to fifty-five years showed almost perfect agreement with the measurements in Table XVIII. Trees in this stand averaging 9.2 inches for the nine-inch diameter class had an average bole of forty feet, a height of seventy-six feet and a crown radius of 8.0 feet. In this same stand the ten-inch diameter class, averaging 10.1 inches, gave an average height of seventy-six feet, a bole of forty-two feet and a crown radius of 8.9 feet.

While the stands available for the ages twenty to sixty years were not by any means abundant the results obtained from such stands are in agreement with the results derived from the assumption that the crown expansion is a linear function of time.

B. Yield Tables

From the data given in the preceding pages the yield tables below have been constructed. As has already been remarked, pure stands do not occur and, therefore, a percentage composition is given in Figure 5, so that the yield in any mixed stand may be ascertained by calculation. It is also true that pure ash-oak stands do not occur, but the percentage of other trees in the stand will depend greatly on the management. Where the percentage of such trees as red maple and gray birch is large at the commencement of the life of the stand, the removal of these will form the greater part of the early periodic thinnings.

For the purposes of this yield table, basswood, beech, and chestnut may be considered as oak in regard to number per acre. Chestnut, however, may now be considered a thing of the past owing to the ravages of the disease *Endothea parasitica*. Both basswood and beech are space demanding like oak. Neither of these trees occurs at all freely in the mature forest, but it is probable that they were present in the original forest in a greater percentage than to-day. Sugar maple, black cherry, red maple, black birch, and yellow birch may be regarded as ash as regards number per acre. All of these trees are crowd enduring and all form clear boles like ash. The difference in the height growth of oak and ash at any period is small and neither tree is in any danger of being overtopped by the other. There is a rather remarkable difference in their growth at about the sixteenth year and onwards. The annual height increment of ash, which is more regular than is the case with oak, suddenly becomes slower, so that the general increment at about the seventieth year is only one or two inches, while in oak it is about four inches. This sudden decline in the rate of growth also occurs in white pine and apparently the height above ground or age at which it takes place varies according to the site.

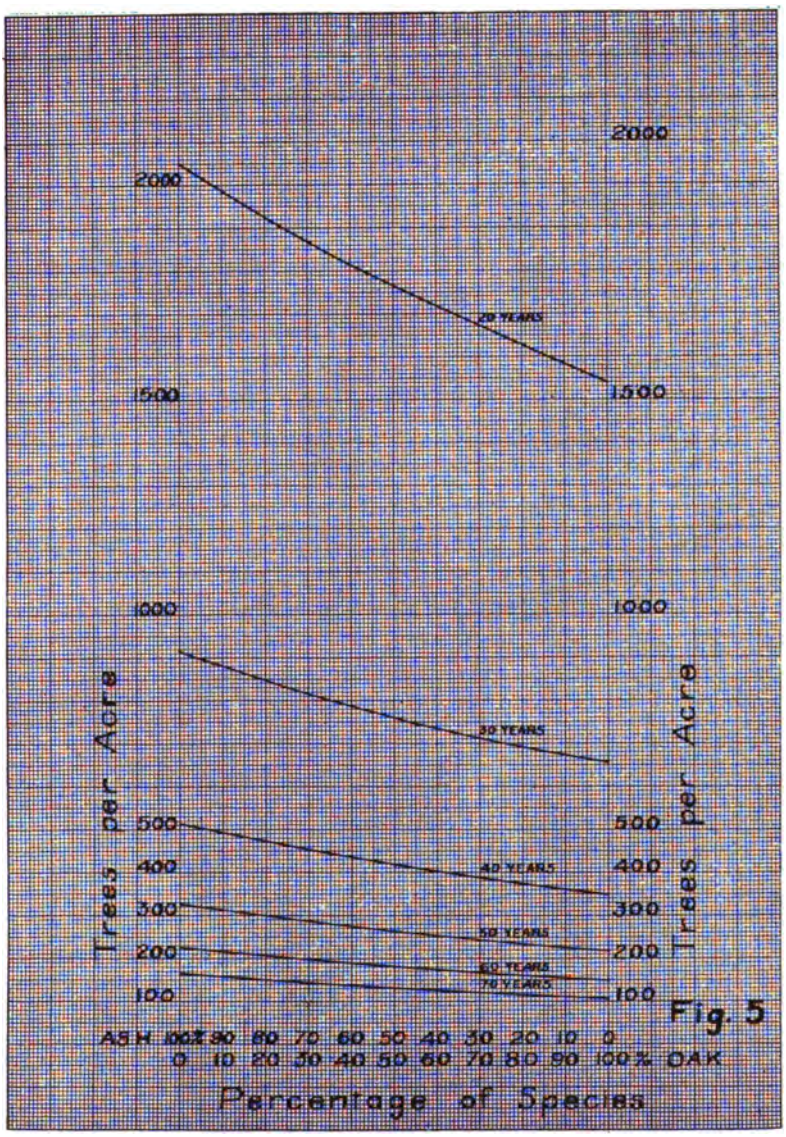

2000
1500
1000
500
400
300
200
100
20 YEARS
30 YEARS
40 YEARS
50 YEARS
60 YEARS
70 YEARS
Trees per Acre
ASH 100% 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100% OAK
Percentage of Species

Fig. 5

The diameter given for oak at seventy years is considerably larger than that given for European oak at the same age, or indeed for any other hardwood. The shortening of the rotations at present employed in the older countries is at present one of the most urgent problems in forest research.

Both the ash and oak as given in the yield tables can be considered as standards for quality I. No better growth is found in this locality. The quality I sites are mainly at the lower elevations. The lower slopes are moister. The same quality soil at a higher and drier elevation must be regarded as quality II. Only two site qualities occur for oak and ash. Where the soil becomes too dry or too wet other species replace these two trees.

From Table XVIII it will be seen that the difference in height growth between oak and ash is very small, the greatest difference, four feet, occuring at the thirtieth year. There is less variation in the average annual height increment of ash, from decade to decade, than is the case with oak. The greatest individual height increment in oak saplings was found to be four feet three inches, and this occurred at the eleventh year. A growth of four feet one inch was also found in the ninth year. Ash does not appear to make any such growth as this.

The lower limit of quality I as indicated by height is shown by the figures given in the following table. Heights below this must be regarded as indicating quality II.

TABLE XX

Age in Years	Height in Feet
10	14
20	34
30	50
40	61
50	69
60	74
70	77

The heights for the later years given for oak, quality I, in Table XVIII, are comparable with those given for oak, quality I, in European yield tables, as given by Wimmenauer in *Forst und Jagdt Zeitung* in 1913. What is a quality I hardwood site is also a quality I pine site, but the reverse is not necessarily true.

A study of plants associated with the oak and ash on the best sites showed that the following appeared to be the best site quality indicators: yellow violet, *Viola rotundifolia*, jack in the pulpit, *Arisalura triphyllum*, and *Trillium erectum*. These plants were not found on quality II sites.

Assuming that a forest can be placed under intensive management, these tables may serve both as a guide for silvicultural treatment and as a statement of yield.

ASH

Age in Years	Trees per Acre	Height in Feet	D.B.H. Inches	Basal Area Sq. Feet	Cubic Ft. per Acre Saw Logs	Cordwood	Total Yield Cu. Ft.	Bd. Ft.
10	8210	18	1.2	65	..	..		
20	2052	36	2.7	82	..	2131	1231	
30	912	53	4.8	115	..	2650	2650	
40	513	68	6.9	133	..	4104	4104	
50	328	77	8.8	139	..	4756	4756	
60	228	81	10.6	140	4332	912	5244	25,000
70	168	82	12.4	141	4036	1344	5380	28,000

OAK

Age in Years	Trees per Acre	Height in Feet	D.B.H. Inches	Basal Area Sq. Feet	Cubic Ft. per Acre Saw Logs	Cordwood	Total Yield Cu. Ft.	Bd. Ft.
10	7100	16	1.2	56	..	..	..	
20	1540	37	2.7	61	..	924	924	
30	657	57	4.5	73	..	1840	1840	
40	350	68	6.8	88	..	2660	2660	
50	222	75	9.5	109	..	3760	3760	
60	151	82	12.2	122	3694	906	4600	22,600
70	108	85	15.0	133	4108	972	5080	27,400

PRICE INCREMENT

Although on the Harvard Forest the rotation for oak is seventy years, yet there remains the question whether a holding over of the crop would not be justified owing to the increment in price from year to year.

In order to answer this question, annual prices were obtained from both lumber dealers and local furniture manufacturers. There was a wide divergence in the amount of increase from the year 1900. In Figure 6 is given the price increase taken from the books of a large furniture manufacturer. Complete records had been kept for many years. There was a steady increase from 1900 to 1917. In the latter year the first effects of the Great War began to be felt in the local wood using industries. Prices from 1917 onwards mounted rapidly until in 1920 the apex was reached. These inflated values have not been inserted. The price quoted for 1921 is a long way in advance of the 1917 price and this in spite of the fact that it is now some months since the great fall in prices. The price paid for oak to-day is also surprising since the output of the factories is small and they are working on short time. Even at the steady rate at which prices increased from 1900 to 1917, in a few years an almost prohibitive price would have been reached. This curve must surely bend over and a much slower rate of increase ensue. For the future, then, nothing can be learned from the study of the annual prices, except that the price increment cannot continue.

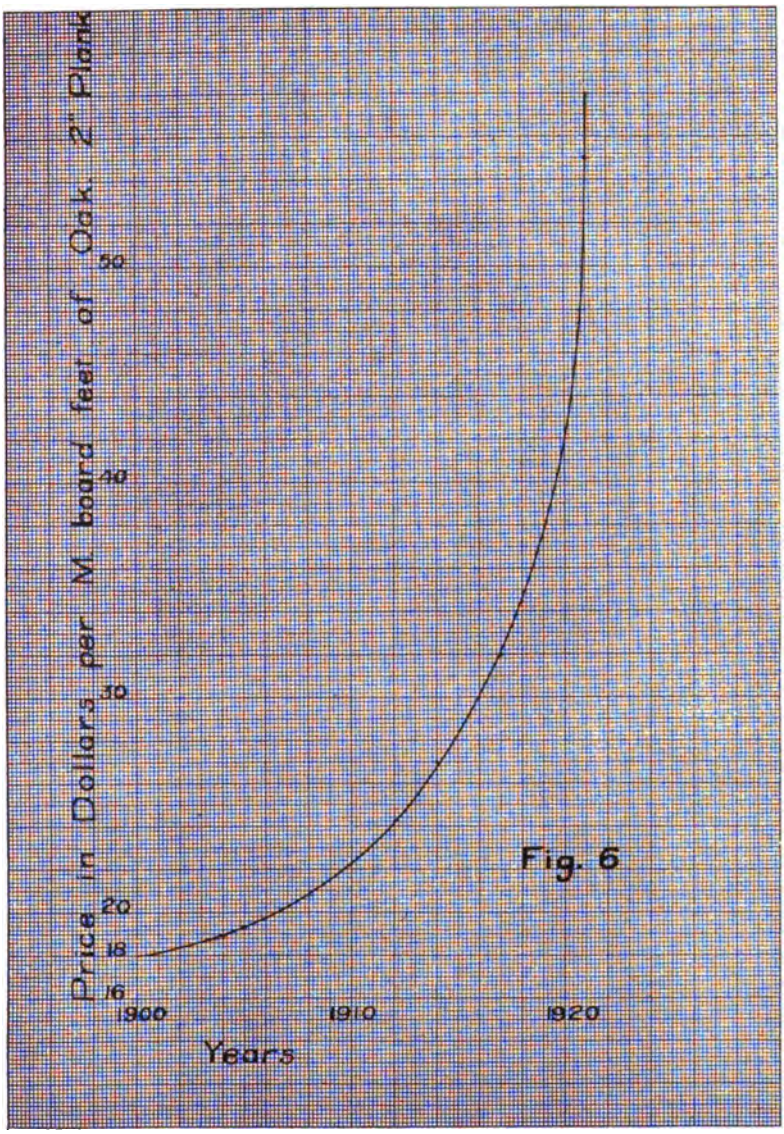

Price in Dollars per M. board feet of Oak. 2" Plank
50
40
30
20
18
16
1900
1910
1920
Years

Fig. 6

TYPICAL ASH TREES

Grown in close canopied high forest. Height of trees: left, 87 ft.; right, 82 ft.

TYPICAL ASH STAND

Age 65 years. D.B.H. central tree, 12".